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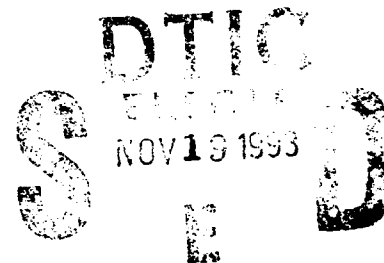
IS SPARING TO AVAILABILITY THE WAY?

A thesis presented to the Faculty of the U.S. Army
Command and General Staff College in partial
fulfillment of the requirements for the
degree

MASTER OF MILITARY ART AND SCIENCE

by

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Fort Leavenworth, Kansas
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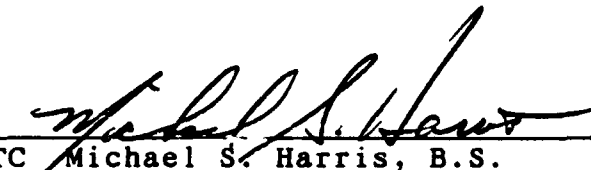
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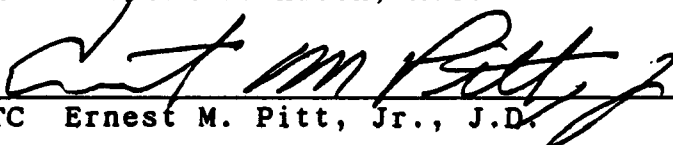
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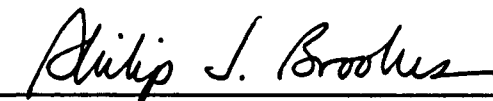
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The opinions and conclusions expressed herein are those of the student author and do not necessarily represent the views of the U.S. Army Command and General Staff College or any other governmental agency. (References to this study should include the foregoing statement.)

ABSTRACT

IS SPARING TO AVAILABILITY (STA) THE WAY? by Major Peter N. Fuller, USA, 135 pages.

The objective of this study is to evaluate the performance of a Sparing To Availability (STA) generated Class IX repair parts stockage list. This STA generated Class IX stockage list could be used either during the initial provisioning and fielding of a new weapon system or used to maintain and replenish Class IX items stocked on a unit's Authorized Stockage List (ASL).

Analysis of data from an STA generated initial provisioning demonstration was used to determine the supply and materiel readiness performance of STA. The STA stockage increased supply and materiel performance, while simultaneously reducing inventory investment costs.

Analysis of data from two STA Proof Of Principal Demonstrations (POP Demo) sites, was used to determine the supply and materiel readiness performance of ASL replenishment determined through STA methodology. Again, the STA stockage achieved increased supply and materiel readiness performance, while simultaneously reducing ASL inventory investment costs.

This evaluation also identified the impact that inaccurate, incorrect, or obsolete input data will have during the development of either an STA initial provisioning or ASL replenishment package.



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TABLE OF CONTENTS

	<u>Page</u>
APPROVAL PAGE	ii
ABSTRACT	iii
ACKNOWLEDGEMENTS	iv
LIST OF ILLUSTRATIONS	vi
LIST OF ABBREVIATIONS	ix
CHAPTER	
1. INTRODUCTION	1
2. LITERATURE REVIEW	10
3. RESEARCH DESIGN	53
4. ANALYSIS	55
5. CONCLUSIONS	117
ENDNOTES	124
GLOSSARY	127
BIBLIOGRAPHY	129
INITIAL DISTRIBUTION LIST	135

LIST OF ILLUSTRATIONS

<u>Figure</u>	<u>Title</u>	<u>Page</u>
1.	SUPPLY SUPPORT STRUCTURE	39
2.	FLOW OF UNITS IN A TWO ECHELON SYSTEM	41
3.	INDENTURED PART STRUCTURE	43
4.	FAILURE FACTORS FOR INF STA PLL	64
5.	FAILURE FACTORS FOR AR STA PLL	64
6.	FAILURE FACTORS FOR CAV STA PLL	65
7.	CUMULATIVE FAILURE FACTORS FOR STA PLL	65
8.	ORIGINAL STA vs SIP PLL	68
9.	ORIGINAL STA vs REVISED STA PLL	68
10.	ORG STA vs REVISED STA vs SIP PLL	69
11.	ASL FAILURE FACTOR DISTRIBUTION	70
12.	ASL CUMULATIVE FAILURE FACTORS	71
13.	ORG STA vs SIP ASL ACCOMMODATION	74
14.	ORG STA vs SIP vs DA 2406 READINESS RATES	76
15.	ORG STA vs REV STA vs SIP vs 2406 RATES	77
16.	NTC STA vs ORIGINAL ASL COMPARISON	82
17.	NTC ASL DEMAND ACCOMMODATION RATES	86
18.	NTC ASL DEMAND SATISFACTION RATES	88
19.	NTC ASL FILL RATES	89
20.	NTC ASL ZERO BALANCE RATES	90

<u>Figure</u>	<u>Title</u>	<u>Page</u>
21.	NTC ASL HIGH PRIORITY FILL RATES	91
22.	NTC MATERIEL READINESS RATES	94
23.	NTC MATERIEL READINESS RATES	95
24.	5TH ID(M) ASL CONFIGURATION	98
25.	5TH ID(M) ASL DEMAND ACCOMMODATION RATES	101
26.	5TH ID(M) ASL DEMAND SATISFACTION RATES	102
27.	5TH ID(M) ASL FILL RATES	103
28.	5TH ID(M) ASL ZERO BALANCE RATES	104
29.	5TH ID(M) HIGH PRIORITY FILL RATES	105
30.	5TH ID(M) MATERIEL READINESS RATES	108
31.	5TH ID(M) MATERIEL READINESS RATES	109
32.	5TH ID(M) DEMAND DISTRIBUTION	111
33.	5TH ID(M) ASL ADD/RETAIN COMPARISON	112
34.	5TH ID(M) ADD/RETAIN ACCOMMODATION (ESSENTIAL)	112
35.	5TH ID(M) ADD/RETAIN ACCOMMODATION (ALL REQ'S)	113
36.	5TH ID(M) ADD/RETAIN SATISFACTION	113
37.	5TH ID(M) ADD/RETAIN FILL RATE	114
38.	5TH ID(M) ADD/RETAIN ZERO BALANCE RATE	114
39.	5TH ID(M) READINESS WITH 9/3 ASL	115

<u>Table</u>	<u>Title</u>	<u>Page</u>
1.	FT POLK BFVS FIELDING SCHEDULE	59
2.	STA PLL/ASL vs SIP PLL/ASL	61
3.	PLL LINES USAGE BY COMPANY	62

<u>Table</u>	<u>Title</u>	<u>Page</u>
4.	PLL LINES WITH FF RESTRICTIONS	66
5.	STA vs SIP LINES AND DEMANDS	70
6.	FT RUCKER AR 710-2 vs STA ASL COMPARISON	80
7.	NTC ASL CONFIGURATIONS	84

ABBREVIATIONS

ACIM	Availability Centered Inventory Model
AMC	US Army Materiel Command
AMDF	Army Master Data File
AMSAA	Army Materiel Systems Analysis Activity
A _o	Operational Availability
AR	US Army Regulation
AR	Armor
ASF	US Army Stock Fund
ASL	Authorized Stockage List
BFVS	Bradley Fighting Vehicle System
CAV	Cavalry
CONUS	Continental United States
DMMC	Division Materiel Management Center
DS	Direct Support
DSU	Direct Support Unit
DCSLOG	Deputy Chief of Staff for Logistics
EMC	Equipment Mission Capable
FF	Failure Factor
FORSCOM	US Army Forces Command
GAO	Government Accounting Office
HHC	Headquarters and Headquarters Company
ILS	Integrated Logistics Support
INF	Infantry
IRO	Inventory Research Office
LBS	Pounds
LRU	Line Replaceable Unit
LSAR	Logistics Support Analysis Record
METRIC	Multi-Echelon Technique for Recoverable Item Control
NICP	National Inventory Control Point
NMCM	Non Mission Capable Maintenance
NMCS	Non Mission Capable Supply
NSN	National Stock Number
NTC	National Training Center
OST	Order-Ship-Time
PLL	Prescribed Load List
PM	Program Manager
POP	Proof Of Principle
RCT	Repair Cycle Time
RO	Requisitioning Objective
ROP	Requisitioning Objective Point
SESAME	Selected Essential Item Stockage for Availability Method
SIP	Standard Initial Provisioning
SRU	Shop Replaceable Unit
STA	Sparing To Availability

CHAPTER ONE

INTRODUCTION

No skill is more important than the corporate capacity to change per se. The company's most urgent task, is to learn to welcome--beg for, demand--innovation from everyone.

Tom Peters, Thriving on Chaos

"No more Task Force Smith's"² is the goal for the post-Cold War US Army, as stated by the US Army Chief of Staff, General Sullivan. Task Force Smith was an ad hoc unit formed to immediately project US Army combat power during the onset of the Korean War. Poorly trained, organized, and equipped Task Force Smith did not perform well in its initial combat operations. General Sullivan's intent is to avoid creating a similar situation during the inevitable and critical down-sizing of the US Army. General Sullivan's statement "No more Task Force Smith's" implies different missions for the Major Subordinate Commands (MACOMs) of the US Army. For the US Army Training and Doctrine Command (TRADOC) this tasking focuses TRADOC's efforts on ensuring the preparation of future task forces for combat through proper doctrinal training and well organized units. The focus of the US Army Materiel Command (AMC) is on ensuring future task forces are provided the

necessary equipment, in sufficient quantities to fight and win in combat. Of equal importance, AMC must ensure the availability of proper and sufficient repair parts to support and sustain these future task forces.

The Problem

As the US Army down-sizes, so does its operations and maintenance account (OMA) budget. Reduction of the OMA budget will impact on the US Army's ability to support the costs associated with both its training and sustainment operations. Reducing the US Army's budget mandates the need to evaluate its ability to conduct and sustain future combat operations. Additionally, the US Army must continue to identify and develop alternative logistic support concepts that can reduce the cost of supporting this future US Army.

The US Army needs to reexamine its logistical support structure with the introduction of new high-technology weapon systems into its inventory. These new high-technology weapon systems utilize a significant number of sub-components that are both extremely expensive and difficult to repair and maintain. The problems associated with the high costs and maintenance is compounded by the difficulty in determining the war time demand rates for these high-technology sub-components.³ There is the potential that the combat effectiveness of a high-technology weapons system may be reduced when the weapons logistical support is not able to ensure its battlefield availability.

Significance of the study

Currently, several US Army organizations and agencies are developing alternative logistic concepts and initiatives to support and sustain the future US Army. The importance of these efforts is reinforced by both Department of Defense (DOD) Directives to reduce operating costs and the generally perceived necessity to reduce the defense budget. In fact, if the US Army is to continue to maintain the high state of readiness needed to accomplish its future missions of rapidly projecting combat power and the sustainment of its forces in contingency operations; the need to reduce operating costs, improve operating efficiencies, and ultimately develop a more responsiveness logistics support system is essential.⁴

Several of the US Army's logistics initiatives are designed to address identified deficiencies found in the current Class IX repair parts supply system. The Class IX repair parts supply system is organized into two operating levels, wholesale and retail. The wholesale level supply support organization is generally responsible for determining requirements, cataloging, procuring, depot level repairs (i.e., rebuild or overhaul), and the distribution of Class IX repair parts.

The retail level supply support organization is the means to integrate repair parts with maintenance operations. Retail maintenance operations are performed at three levels:

general support, direct support, and organizational. Organizational level maintenance is supported by a Prescribed Load List (PLL) of repair parts. Replenishment of PLL items or request for items not stocked on the unit PLL is normally supported by an direct support maintenance company. This unit maintains an Authorized Stockage List (ASL) which normally includes all items that are found in its supported unit PLLs, and also those repair parts needed to support maintenance operations by the direct support maintenance company.

The US Army's current logistical support structure evolved from experiences associated with earlier generations of less complex weapon systems. These weapon systems used either mechanical, hydraulic, or simple electrical parts to operate. These repair parts were typically very easy to fault diagnose, and were normally relatively inexpensive.

Due to the relatively inexpensive cost of the components, the US Army could simply buy enough repair parts to sustain both current and future demands for the repair part. However, most components used in the new high-technology weapon systems are considerably more expensive than those repair parts used to repair previous weapon systems. The high costs of repair parts creates a more difficult problem when coupled with the high investment costs associated with the Test Measurement and Diagnostic

Equipment (TMDE) required to repair the high cost repair parts.

Research Objective

This thesis will specifically examine Sparing to Availability, an alternative methodology used to determine the optimal least-cost stockage mix of retail Class IX repair parts. Although I recognize the importance of the many other equally important logistic support concepts under development such as: Stock Funding of Depot Level Repairables (SFDLR), Objective Supply Capability (OSC), Total Asset Visibility (TAV), Usage Based Requirements Determination (UBRD), Readiness Based Maintenance (RBM), and Battlefield Spares System (BSS), I will only address Sparing To Availability.

The thesis topic, IS STA THE WAY?, combines of two areas of responsibility from my previous assignment with the US Army Materiel Systems Analysis Activity (AMSAA). AMSAA developed the Sparing To Availability (STA) methodology after examining the US Army's retail Class IX repair parts system. AMSAA identified a US Army-wide Class IX repair parts problem when Army Regulation (AR) 710-2, Supply Policy Below the Wholesale Level procedures were utilized to develop a units Class IX repair parts ASL and PLL stockage list. The STA methodology was developed in an effort to address this US Army-wide Class IX problem. STA methodology can

determine the optimum Class IX repair parts stockage utilizing either an equipment availability readiness goal or instead, use the budget allocated for Class IX repair parts inventory investment. STA can provide the US Army with the potential to significantly reduce Class IX repair parts stockage costs, while maintaining equipment readiness goals.

In addition to conducting many studies for both DCSLOG and AMC related to logistics and readiness analysis issues; AMSAA serves as the independent technical and logistical evaluator for both Major and Non-Major US Army Acquisition Programs. As such AMSAA provides independent assessments to DCSLOG, AMC, Program Managers, other organizations and agencies, and senior Army decision makers. During my assignment with AMSAA, I provided Integrated Logistic Support (ILS) assessments on many programs ranging from the XM11 (compact 9MM pistol) to the KE-ASAT (Kinetic Energy-Anti Satellite) System. After completing several assessments, I felt that many ILS issues were created by problems in the program areas of cost, performance, and scheduling. Problems in these areas can adversely impact on the program manager's ability to provide adequate ILS due to either the limited availability of program funds and/or the time to develop and provide for an adequate ILS plan. With the development of increasingly complex weapon systems, combined with the US Army's future down-sized budget, the requirement to provide initial provisioning Class IX repair

parts support at the least cost has become increasingly paramount.

Research Question

Primary Question: Will the application of the STA methodology improve or degrade retail Class IX repair parts costs and materiel readiness when used to determine initial provisioning and replenishment requirements?

Secondary Question: Will the application of STA methodology support the deployment options of new systems and units currently supported by ASLs?

Research Methodology and Scope

The AMSAA STA program was criticized by other agencies and organizations during the initial implementation and conduct of the National Training Center (NTC) Proof Of Principle (POP) Demonstration. The NTC POP Demonstration is an ongoing field verification and validation of the STA methodology directed by DCSLOG through its field operating agent, the Strategic Logistics Agency (SLA).

To better understand the reasons for the initial criticism and to better evaluate STA as a valid alternative to determine Class IX repair parts requirements, this thesis will develop the question, IS STA THE WAY?. This thesis will first examine the history, development, and problems of the US Army's current retail Class IX repair parts system. I will then highlight the differences between AR 710-2

procedures and those used in the STA methodology. It is hoped that through this analysis the reason for its development and advantages over the current system will become evident. Additionally, I will examine the other Department of Defense (DoD) services and Nations currently using a sparing to availability methodology to determine Class IX repair part stockages. Through the examination of sparing to availability methodology utilization by other DoD organizations I will attempt to support and validate the need for the US Army to use Sparing To Availability as its Class IX inventory methodology.

Assumptions

This thesis was developed using the following assumptions: first, there is a need for an alternative methodology to determine retail Class IX repair parts stockage, and this will remain a critical concern for of the US Army; second, the current Sparing To Availability POP Demonstration will continue, and thus providing sufficient supply performance data (i.e., supply satisfaction, accommodation, fill rate, and materiel readiness rates); third, the US Army will continue to field high-technology weapon systems that require and utilize computers and other complex electronic and electro-optical components; and fourth, there is the ability to determine materiel readiness through the evaluation of a units Class IX repair part

supply performance, i.e., demand accommodation, satisfaction, and fill rates.

Definitions

All definitions, symbols, and acronyms used in this thesis are listed at Appendix A.

CHAPTER TWO

LITERATURE REVIEW

History sometimes yields lessons of direct applicability which too often go unrecognized and unheeded and sometimes deliberately ignored, presumably on the naive assumption that this time everything is different.

Army Materiel Command Board

The primary purpose of this chapter is to first, review for the reader the status of the existing research on the thesis topic. The secondary purpose of this chapter is to examine in-depth for the reader the policies, procedures and associated problems with both the current and future repair parts inventory determination systems. Additionally, this extensive research and subsequent discussion of the available information will enable the reader to better understand both the analysis conducted in Chapter Four and the conclusions and recommendations stated in Chapter Five.

This chapter is organized into the following eight sections:

Section one provides background information and an overview of the organization and structure of the US Army supply system. This section provides the reader with a general understanding of the functions and responsibilities of the US Army's wholesale and retail systems. Additionally

discussed in this section are the US Army's classes of supply and how it funds its Class IX repair parts.

Section two examines in detail US Army Regulation (AR) 710-2, Supply Policy Below the Wholesale Level. AR 710-2 identifies the policies and procedures used to determine Class IX repair part inventory stockage.

Section three identifies and evaluates the literature that discusses the inventory management and control problems associated with use of AR 710-2 procedures and policy. This information was useful in assisting me to both understand AR 710-2 policies and procedures and the reasons for the initiation and subsequent development of the US Army Sparing To Availability inventory model.

Section four is a review and description of the policies and procedures of AR 700-18, Provisioning of US Army Equipment.

Section five is a review of literature identifying the problems found with the associated use of AR 700-18.

Section six is a review of the literature available on sparing to availability models. This section will first examine the US Army's Sparing To Availability model. After examining the US Army's STA model, this section will examine the sparing to availability models used by other DoD services and countries. This thesis will not examine in detail the mathematical formulas or equations used in any particular model, but rather only the major elements and

basic assumptions found in each model.

Section seven is a review of literature found on the commercial or business use of logistics research and identify the use of any similar sparing to availability models.

The eighth and last section of this chapter is a short summary of information provided in this chapter.

Section One. Background

Due to the size and complexity of the US Army's logistics support operation and organization, the US Army has sub-divided this large and complex logistics support system into two more manageable elements; wholesale and retail levels of supply support.

The wholesale level is responsible for the supply support that includes the National Inventory Control Points (NICP), depots, terminals, arsenals, central wholesale data banks, plants and factories associated with commodity command activities, and special US Army activities retained under direct control of Headquarters, Department of the Army (HQDA). Wholesale functions are normally performed in the Continental United States (CONUS). The wholesale system procures supplies for the US Army from commercial sources or from US Government owned plants. Wholesale supply support is accomplished by the distribution of supplies to the lower or retail level for stockage or issue to users.⁶

The retail level is the level of supply support

below the wholesale level. Retail level stockage is generally oriented toward attaining maximum operational readiness of support units, and therefore is based on demand or item essentially. Installation supply and maintenance activities, Direct Support (DS) organizations, and General Support Units (GSU) usually are engaged in retail level supply support.

The wholesale and retail supply support organizations encompass two extremely broad activities of providing both materiel and services. The differences between these two broad logistics activities is usually distinguished because materiel refers to the providing of items or supplies, whereas services are generally non-materiel in nature. However, maintenance of materiel is sometimes considered a service because it is essential to effectively provide the service. Materiel or supplies are identified as those items needed to equip, maintain, operate, and support military activities. Supplies are used to support administrative, combat, or general logistic requirements. For planning and administrative purposes, supplies are divided into 10 classes. This thesis will only address those issues related to the determination of Class IX repair parts inventories. Class IX supplies include repair parts and components that are comprised of kits, assemblies and sub-assemblies, reparable and nonreparable repair parts required for maintenance support of all

equipment. Class IX repair part items are also subclassified into categories that support a particular piece or type of equipment, i.e., A-Aviation equipment and aircraft, O-Combat vehicles.⁷

At the wholesale level, Class IX support operations are responsible for the forecasting of the Class IX repair parts required to support anticipated retail level Class IX demands. The wholesale level system also has the responsibility to evaluate demands generated by the retail level and determine if the requirement exists to either procure more of that item or if the item should be prioritized for depot maintenance repair or rebuild. At the wholesale level, cataloging of a repair parts and the distribution of the repair part to the requesting retail level organization is conducted. The wholesale system coordinates and conducts operations through six NICPs: Aviation and Troop Systems Command (ATSCOM), Armaments, Munitions, and Chemical Command (AMCCOM), Communications-Electronic Command (CECOM), Missile Command (MICOM), and Tank-Automotive Command (TACOM). The NICPs are integrated with supply and maintenance depots of both the Defense Logistics Agency and the US Army. As of March 1992, the value of the US Army wholesale Class IX inventory was valued at approximately \$21 billion dollars.⁸

At the retail level there are three retail maintenance organizations requiring Class IX repair parts:

General Support (GS) maintenance, Direct Support (DS) maintenance, and Organizational (ORG) maintenance. Class IX repair parts support at the Org level are provided by a unit Prescribed Load List (PLL). An item on a PLL must meet specific demand criteria for inventory stockage. Specific demand criteria for stockage on a unit PLL is further discussed in section two of this chapter, which examines AR 710-2 policy and procedures used to determine PLL stockage. Unit PLLs are replenished from stocks managed by a DS maintenance company. The DS maintenance company maintains an Authorized Stockage List (ASL) which normally includes both items found on the supported PLLs and those items the DS maintenance company requires to perform its DS level maintenance tasks. Class IX repair parts found on an ASL must also meet specific demand criteria for stockage and retention. Stockage criteria is further discussed in section two of this chapter, which will examine the AR 710-2 policies and procedures that are used to determine ASL stockage.

Retail level Class IX stockage is generally oriented towards attaining maximum operational readiness of supported units, and therefore is based on demand or item essentiality. The value of the retail inventory is difficult to determine because such data is not centrally maintained. However, according to a recent General Accounting Office (GAO) report, the value of the US Army

wide retail inventory is estimated at approximately \$4 billion dollars.⁹

The funding of Class IX repair parts is through two distinctive types of financial systems. One type is the annual appropriations by the US Congress and the other is monies funded by DoD in a revolving capital fund. Annual appropriations of the US Congress normally only support the funding of Class IX repair parts used to support initial provisioning during a systems procurement. Additionally, section four discusses the procurement and initial provisioning process. Class IX repair parts used to support the operation and maintenance of fielded systems is funded by the Army Stock Fund (ASF).

The ASF is a revolving, working capital fund authorized by the Secretary of Defense in an effort to improve financial management within each respective service. The ASF is used to finance inventories of stores, supplies, materials, and equipment as designated by the Secretary of the Army. The ASF works similar to a commercial business, establishing a supplier-customer relationship. The customer (retail user) determines what, where, and when it wants an item, and the supplier (wholesale) determines how much to buy, stock, produce, and to distribute of an item. The customer's (retail user's) payment for the item replenishes the fund, providing the capital for continuing operations.

Section Two. AR 710-2

This section will examine AR 710-2 policies and procedures. AR 710-2 regulates the supply policy for supply operations below the wholesale level and is applicable in both peacetime or war. Specifically, AR 710-2 provides the specific policies and procedures for the accountability and management of Class IX repair part stocks that are stored at the ORG, DS, GS, or at the installation level of supply support activity, responsible for issuing to the customer (user).

Although AR 710-2 identifies the responsibilities for the accountability and management of Class IX repair part stocks, at the user level, these stated policies and procedures are imbedded in the computer software called Standard Army Retail Supply System or SARSS that operates on the Direct Support Unit Standard Supply System (DS4). SARSS is an integrated and automated logistics system that manages the routine supply and stock control procedures of the division materiel management center (DMMC) and any nondivisional direct support units (DSU).

AR 710-2 identifies that DCSLOG is responsible for all Army supply policy, and all subordinate commanders are to ensure compliance with the applicable policies as described in the regulation. Additionally, any deviations from this regulation are only made with prior approval by DCSLOG.

The next important area discussed in AR 710-2 are supply performance standards. Supply performance standards are management tools used to access the effectiveness of the supply support system. There are two types of supply performance standards; the first type reflects the local management policies impact on the inventory, against established DA standards. The second type reflects the performance of the supply system, regardless of local management policies and procedures. However, supply performance statistics are not reported to higher level, and are currently only used as a management tool for local commanders.

A reader must have an understanding of several important supply performance standards to better appreciate the analysis in chapter four. The first important performance standard is demand satisfaction. Demand satisfaction is a measure of ASL depth, and is a percentage representing the number of ASL demands completely filled divided by the total number of ASL demands. Simply stated, demand satisfaction states: do we stock enough on our ASL of what our customers want?

Another important supply performance statistic is the percentage of ASL lines with a zero balance and with a valid due out (DO). Although, this performance standard may indicate a condition generated within the wholesale or retail supply system, it may also reflect the performance of

the local supply activity. Items identified at zero balance and with a valid DO, can represent items that the local supply manager should increase in quantity to provide for adequate stockage, rather than representing a shortage of the item at the wholesale level.

The next important area addressed in AR 710-2 is the method used to determine inventory stockage and quantities. Organizational units are authorized to stock items on a Prescribed Load List (PLL). PLL's consist of unit maintenance repair parts that are demand supported, non-demand supported, and initial provisioning items that are required to support a new piece of equipment to the unit. To stock a demand supported unit level maintenance item, three demands are required in 180 days for an active duty unit or 360 for a Reserve or National Guard unit. Additionally, the demand supported part must have an essentiality coding of C on the Army Master Data File (AMDF). To retain the item on the unit PLL, the item must have one additional demand within 180 days. The stockage quantities of the other two categories found on a PLL is simple to determine. For all non-demand supported items, the first general staff officer in the unit chain of command must authorize the stockage of the non-demand supported item. For those items identified to support initial provisioning, a unit PLL manager is not authorized to reduce the initial provisioning item during the first year

year of stockage, or delete the item until it was stocked for two years.

The number of items or lines stocked on a units PLL will not exceed 300 without the approval of a general staff officer. Actual stockage quantities are determined by computing the demand rate multiplied by the average customer wait time (ACWT), normally a 15 day period. Minimum stockage is that quantity supported by demands, unless constraints are imposed by higher headquarters.

As with a PLL, an ASL must also meet specific demand criteria: items are authorized for stockage after the ninth demand in a 360 day period, and are deleted when the item does not receive at least three demands within the most recent 360 day period. For missile, special weapons, engineer, intelligence gathering, and aviation equipment, a stocked item will only require three recurring demands in a 360 day period to stock, and only one recurring demand to retain. ASL initial provisioning items, similar to the procedures used with a PLL, cannot be reduced during the first year or deleted prior to stocking for two years.

However, unlike the simple method used to determine the PLL stockage levels, the method used to determine the ASL stockage levels is quite complex. Each ASL item must have a Requisitioning Objective (RO) that is the maximum quantity of the item authorized to be on hand and on order at any time. Any materiel on hand that is above the RO is

considered excess. The computed RO will consist of an operating level (OL), order ship time (OST) and a safety level (SL). A Reorder Point (ROP) is the sum of the OST and SL. DS4 will automatically compute the RO and ROP of all demand supported items maintained on the ASL.

Stockage of reparable items for which the unit has the ability to repair, are computed differently than when the item is not repaired by the unit responsible for the stocking of that item. The ROP of those items is computed as the sum of the Repair Cycle Level (RCL), the OST, and the SL. The RO is computed as the sum of the ROP plus the OL.

Finally, AR 710-2 states that the headquarters responsible for the management of the ASL will appoint a review board to assist in its management. The board should meet quarterly to review and approve additions and deletions of items to the ASL. This board is not required for management of unit PLL's, but rather done by the unit commander or his delegate.

As previously stated, any material found on the ASL that exceeds the authorized RO is considered excess. Additionally, any item that is non-demand supported is also considered excess. However, units are allowed to stock the following categories of non-demand based items: mandatory parts list items; those items directed for stockage by HQDA; management discretion items; items that the unit wants to stock on its own discretion (limited to 5% of the total

number of demand supported lines in the ASL); and finally all initial provisioning items. Non-demand supported items are identified as Non Stockage List (NSL) by the DS4 system, and recommended for turn-in to the wholesale level.

Funding for the purchase and subsequent replenishment of Class IX repair parts is accomplished with the previously discussed Army Stock Fund.

Section Three. Problems With AR 710-2 Policy and Procedures

After completing section two of this chapter, a reader would expect that it was relatively simple to determine the authorized PLL or ASL stockage for a unit. However, a significant number of studies and articles are available identifying the problems with the use of or adherence to AR 710-2 policies and procedures.

A significant number of studies addressing retail level Class IX inventory problems are found in GAO reports. A majority of the GAO reports addressing Class IX problems are published after 1985. Prior to 1985, all Department of Defense organizations turned in excess items through property disposal channels. In 1985, the Office of the Secretary of Defense (OSD) issued a directive which stopped this practice. OSD thought that its military departments were purchasing new items, while at the same time disposing of the same item through a separate channel. This 1985 OSD directive generated a considerable buildup of excess

materiel, however, more importantly this directive increased the visibility of the DOD wide excess problem.¹⁰

One of the initial GAO reports issued in 1987, evaluated Class IX supply operations at both Ft. Campbell, Kentucky and Ft. Hood, Texas. Again, the GAO report determined there was a considerable amount of excess materiel stocked by both units, however, this report also identified that 60% of the items used in 'controlled substitution' operations, were for items not stocked on the unit ASL. This report illustrated both the misuse of maintenance personnel and assets for performing 'controlled substitution' operations due to the lack of repair parts, and the potential for cannibalization (see Appendix A) of major end items.

The problems identified in GAO reports of the late 1980's are still found in GAO reports of the 1990's. A GAO report published in 1991, found the same problems with excess Class IX items, and recommended that the US Army reduce its Class IX inventory in its division level units, by only stocking demand supported items.

A 1991 GAO report evaluated the Class IX supply operations at four CONUS divisions in an attempt to determine if: first, the US Army needed to buy and maintain all of the items it stocked at division level; and second, could the US Army reduce its investment in inventory at the

divisions without adversely affecting supply responsiveness and performance.¹¹

GAO determined that non-demand supported items accounted for 13,628 lines or about 42% of the 32,221 total lines combined from all four divisions. The 42% of non-demand supported lines represented \$77 million or about 53% of the \$147 million total value of the combined authorized inventory found at all four divisions.¹²

Additionally, this GAO report determined that divisions were not releasing materiel in excess of the authorized RO back to the wholesale level for redistribution.

GAO recommended that the US Army follow its own supply policies and procedures as described in AR 710-2, however, GAO also recommended that the US Army re-evaluate and explore new opportunities to reduce its inventory investment in demand supported items. GAO specifically recommended that the US Army maximize the use of direct vendor deliveries and expedited deliveries from its wholesale depots. GAO also recommended that these efforts should be coupled with the re-evaluation of the methodology used to determine stockage levels of demand supported items. Any efforts in this area should evaluate and reflect the availability of improved technologies in communications, transportation, and inventory distribution methods.¹³

The most recent GAO report, conducted during the

summer of 1992 and currently still in an unofficial draft format, identifies and discusses the same issues and problems found in previous GAO reports i.e., excess demand supported items and non-demand supported items found on division ASL's.

This GAO report determined, after reviewing the Class IX operations of the six CONUS divisions, that over \$28 million of the \$157 million combined total demand supported inventory cost did not meet AR 710-2 criteria for ASL retention. Additionally, GAO determined that over \$21 million of the previously identified \$28 million represented items that did not have any demands during the previous 12 month period and should not be retained on the evaluated division ASL's.¹⁴

GAO concluded that of all of those items meeting the criteria for stockage on the division ASLs, 41% of the items had 3 to 12 demands during the last 12 month period. However, GAO also stated that those same items accounted for less than 8% or \$37 million of the \$468 million total combined inventory costs. Conversely, items with greater than 13 demands in the last 12 month period represented 92% of the total value of issues. GAO specifically stated that the current methodology used to determine demanded supported inventory stockage should be changed to better optimize the US Army's inventory investment.¹⁵

This draft GAO report also addressed the current

Proof Of Principle (POP) Demonstrations of the US Army Sparing To Availability concept. GAO specifically "recommends that the Secretary of the Army not approve the "sparing to availability" concept for implementation at the retail level until it can be clearly demonstrated that the concept can achieve its intended objectives and that it will not conflict with the objectives of a single supply system."¹⁶

This draft GAO report concluded that STA would both increase the number and quantity of items stocked at the retail level and additionally give the retail managers greater latitude in determining the composition of the authorized inventory.¹⁷

In addition to GAO reports, there are other sources available that address issues and problems associated with the use of AR 710-2 policy and procedures. An extensive report was prepared by DCSLOG in 1988, titled Causes of US Army Class IX Excess At The Retail Level. This report identifies common problems found US Army wide related to the causes of Class IX excess. Specifically, this report states: first, that excess is a significant problem, even with the increased emphasis on addressing the problem; second, that the DS4 automated system has many errors, collectively causes the generation of excess; third, many units are not repairing reparable items, but rather evacuating the items as excess and then re-ordering the same

item through the supply channels; fourth, too many repair parts are provided in initial provisioning packages; fifth, quarterly ASL reviews create too much ASL turbulence, and sixth, there are no incentives in preventing the accumulation of excess, only incentives for getting rid of the excess.¹⁸

Another significant source of information on the problems of the US Army's Class IX inventory system, is found in reports published by the US Army Audit Agency (AAA). A AAA report published in 1987, evaluated the Class IX supply operation at Ft. Rucker, Alabama. This AAA report determined that there was a considerable amount of excess stocked by the Ft Rucker ASL. More importantly, the report also determined that 53% of the items requisitions by the unit were not stocked on the unit ASL. Additionally, the report noted that 68% of those items requested by the unit had an individual price of less than \$50 dollars.¹⁹

In addition to the previously identified government reports identifying problems with the US Army's current Class IX system, there are numerous articles written in military professional journals that address the same problems. Typically, these articles address the Class IX problem from the perspective of the user or from the retail inventory manager level.

In addition to the information addressed previously, there are a significant number of the government reports and

studies that address concerns associated with either the fielding of or the use of both low density or highly reliable systems. Many of the previously discussed studies found low density equipment did not generate sufficient stockage due to the low number of systems generating demands during a given time period. However, the term low density did not indicate that the piece of equipment was not critical, only issued in a limited or low number. Conversely, if a system demonstrated a high degree of component reliability, then it too would not generate a sufficient amount of demands to meet AR 710-2 stockage criteria, impacting on the desired equipment readiness goals.

Section Four. AR 700-18

AR 700-18 sets forth the policies, objectives, and assigns responsibilities for the initial provisioning of US Army weapon systems and major end items.

The primary objectives of the US Army initial provisioning process is to ensure that the minimum amount of initial stocks or support items and associated technical documentation are available to support both the using unit/user and to the supporting maintenance and supply unit. This supply support must be provided prior to the actual fielding of the system.

Initial stocks are those items required to sustain the programmed operation of the system and or end item until

normal replenishment can be accomplished (normal replenishment as per AR 710-2). Equipment in the form of a major end item is provided to support the stated system availability or system readiness objectives. Supply support is provided at the least initial investment cost to also support the system readiness objectives.

The computation procedures and formulas used to determine both the wholesale and retail level supply support requirements is called the Standard Initial Provisioning (SIP) model. This is a manual computation based on the projected requirements generated by the newly fielded system. However, as of 1990, the AMC CDR with DCSLOG concurrence, directed that all future fielding governed by AR 700-18, reflect the utilization of an optimization model rather than the SIP model, when determining initial provisioning requirements. This optimization model is based on the need for a system to achieve a desired operational availability (Ao). The US Army's optimization model is called Selected Essential Item Stockage for Availability Method or SESAME. The SESAME model optimizes availability based on the lowest cost mix of support items needed to achieve the required operational capability.²⁰

Both of the provisioning models used (SIP or SESAME) will only stock items with an essentiality code of C, D, or E (mission essential, safety requirement, or legal requirement).

Funding for the purchase of initial provisioning Class IX repair parts is provided through appropriations authorized and allocated by the US Congress. A Program Manager must allocate funds for the Total Package Fielding, which includes the Class IX repair parts determine by SIP or SESAME.

Section Five. Problems with AR 700-18

Although AMC and DCSLOG directed in 1990, that Program Managers use the SESAME methodology when determining their initial provisioning Class IX requirements, there are still some PM's who still do not utilize SESAME to determine the initial provisioning stocks required to support their Total Package Fielding. PM's have given a multitude of reasons why they do not use SESAME, ranging from the reason it is too difficult to operate, to that SESAME did not meet their requirements or needs. However, as of the writing of this thesis, a majority of the PM's currently are or plan to utilize SESAME methodology when determining their Class IX stockage requirements. Individuals involved in or aware of the US Army's Acquisition System would agree that the fielding of a new weapon system is a complex and detailed endeavor, requiring the system's Program Manager (PM) to carefully balance the anticipated needs of the gaining unit with its associated cost to the US Army. However, as illustrated in the 1988 DCSLOG Study, Causes of US Army Class IX Excess At The Retail Level, initial provisioning

stocks many times do not generate any demands within the two year initial provisioning period.²¹ The DCSLOG study additionally concluded that a sufficient number of items provided during initial provisioning were automatically changed to NSL after two years of no demands and thus declared excess. This study illustrates the impact of either understocking or overstocking Class IX repair parts during initial provisioning. If the ASL is understocked, then the unit is continually ordering demanded supported items. This impacts on the unit by forcing the unit to spend its own limited ASF monies, and more importantly, decreasing the unit readiness rate due to logistics down time. If the ASL is overstocked, the unit is maintaining and managing items that are not providing any benefit to the unit and additionally, overstockage puts the burden on the unit to excess the items back to the wholesale level after two years. Additionally, excess items increase the fielding costs of a system.

These initial provisioning problems were also identified in a report published in 1989 by AMSAA, during their development and implementation of the Ft Polk Bradley Fighting Vehicle System (BFVS) Initial Provisioning Sparing To Availability demonstration. AMSAA concluded that even after approximately 10 years of world wide fielding of the BFVS, the BFVS PM was still utilizing a significant number of contractor generated engineering estimates used to

support the initial provisioning of the BFVS in late 1979 and early 1980. These contractor engineering estimates were used to determine the anticipated failure rate of the repair parts used to generate stockage lists in SIP.¹²

After revising the original engineering estimates with new data, AMSAA developed a SESAME based BFVS repair parts stockage list which in turn was compared with the stockage list generated by the BFVS PM using SIP. These two lists were presented to the fielding unit and authorization was requested and received from HQDA for the use and subsequent validation of the SESAME generated stockage list.

AMSAA conducted the demonstration and study from May 1990 through November 1991. This demonstration evaluated both the actual SESAME package against the previously recommended package generated using SIP procedures. With the use of computer simulation, the performance of the proposed SIP package was evaluated against the actual SESAME or STA package. The STA package was lower in costs (\$2.2 million vs \$2.9 million for SIP), additionally STA package was expected to provide a higher operational availability (90% vs 43% for SIP) while supporting the fielding of 219 BFVS at the 5th Infantry Division (Mech), Ft Polk, Louisiana.

The supply performance of each package was evaluated on actual and simulated (SIP) parts usage, supply accommodation, and system readiness. This study

demonstrated that on the average, the STA PLL's covered three times as many demands then the proposed SIP PLL's. The STA ASL covered twice the number of demands then that of the proposed SIP ASL.²³

The STA package also performed better than the proposed SIP package in all areas of supply accommodation performance. The STA PLL's performed 13 to 19 percentage points better than the proposed SIP PLL's, while the STA ASL performed 23 to 31 percentage points better than the proposed SIP ASL. Additionally, the STA package had an eight percentage point higher readiness rate than the proposed SIP package.²⁴

This study found that changes on the AMDF can create a substantial impact on the parts stocks, regardless of the provisioning model used. This study found that during the demonstration, 110 items previously stocked with an essentiality code of C, D, or E were changed to non-essential, and thus not authorized for stockage. Additionally, over 260 items were coded as non-essential yet caused the BFVS to be classified as non-mission capable due to lack of this 'non-essential' repair part.²⁵

Another source used to identify current problems with AR 700-18 policy and procedures was an AMSAA internal Division Note, titled An Introduction to Sparing To Availability, dated 1992. This report identified several problems with the SIP model found in AR 700-18.

One significant problem found with the use of SIP is its inability to "explicitly consider and respond to supply or operational performance targets."²⁶ Furthermore, SIP methodology is not flexible and requires management input to change recommended stockage lists. SIP also does not differentiate between high and low dollar cost items, and additionally, does not respond to budget considerations.²⁷

Section Six. Sparing To Availability

Concurrent with the release of Standard Initial Provisioning Policy in 1977, was the recognition of the problems associated with its use. In an effort to correct these problems, AMC directed AMSAA to develop an inventory methodology that would support operational readiness at the least cost.²⁸

However, prior to this effort in 1977, various Department of Defense (DoD) military departments had conducted a considerable number of studies and research into the area of logistics. These logistical research efforts have generally revealed and thus focused on five specific types of statistical problems in the areas of: demand prediction, adaptive inventory control, operational readiness, detection of wearout, and surveillance. Although all of these areas are important, this thesis will only focus on those studies relative to the issues of demand prediction and adaptive inventory control.

The statistical analysis related to the demand

prediction of military repair parts is a major area of study within the DoD. The majority of the demand prediction studies focus on specific areas relating to inventory control, maintenance and replacement operations and procedures, and repair part and inventory surveillance. The statistical methods used for forecasting future repair part demands is normally organized into two main types: methods for extremely low demand patterns, and methods for regular or high demand rate patterns.²⁹

The first major study in this area was conducted in 1957, by the US Navy to better understand low demand patterns. This study evaluated mechanical and electrical repair parts demand history data generated by twelve submarines during a four year period. The US Navy study concluded that the demanded items by the twelve submarines were both low and sporadic.

About 75% of the items were not demanded at all. Moreover, during the entire four-year period for each submarine and its supply activity, 70% of the items demanded were demanded only once. Approximately 90% of the items demanded were demanded at most twice. [Furthermore] almost all items that were demanded in one year were not demanded in another year.³⁰

The results of this study led to the development of a new methodology by the US Navy for the forecasting of repair parts with low demand rates. This new methodology predicted that demand was based on the item or major component the repair part was installed. The unique feature of this new model was not only its accuracy in forecasting

demands, but that it could also determine the projected demand rates of new repair parts that belonged to a certain group and or item. Another unique feature of this model was its ability to forecast demand rates for new parts, that did not have previous demand histories.³¹

Although the US Army's efforts were not directly related to any previously conducted studies of the other services, information available from these previous studies and commercial sources assisted the US Army during its development of the SESAME model. As previously noted the SESAME model was and is used to support US Army initial provisioning requirements, and is a sparing to availability methodology. SESAME and the concurrent development of sparing to availability models by other DoD services, led to a directive issued on the subject in 1982 by Mr. Juliano, then the Assistant Secretary of Defense.

Mr. Juliano issued a DoD memorandum stating that a sparing to availability model should be the requirements determinations concept/methodology used within DoD.³² The Juliano memorandum specifically stated:

The traditional approaches to determining inventory levels and measuring supply performance have been related to the satisfaction of demands for items of supply. Such approaches do not normally identify the degree to which various secondary items contribute to the operational availability of weapon systems. We are now attempting to relate stockage decisions to the effect they have on weapons system readiness. This concept represents a significant departure from traditional supply management in that it shifts the materiel manager's concern from item-oriented inventory performance to weapon system performance. Adoption of

the concept will mean a move toward visibility and management of space and repair parts requirements by weapon system. The Army, Navy and Air Force are in various stages of using sparing to availability models to compute spare parts requirements for selected weapons systems.³³

In 1984, the Office of the Secretary of Defense issued a memorandum on DoD's Weapon Systems Management Concept, stating explicitly that determination of all DoD retail Class IX inventory stockage requirements could and should eventually be computed using a sparing to availability methodology.³⁴

The best available source on the US Army Sparing To Availability model is a report published in 1992 by AMSAA. In this report, the Inventory Research Office (IRO), an element of AMSAA who developed the SESAME or Sparing To Availability methodology, identifies the three fundamental questions on which the STA methodology is based:

What are the objectives or goals of the repair parts stockage lists? What stockage alternatives or tradeoffs are available? What, if any, constraints are on the development of the repair parts stockage lists?³⁵

The report states that IRO used the three questions as the basis for their effort, and determined that the requirements determinations concepts and methodologies should accept as input the answers to these three questions, and recommend repair parts stockage lists based on the answers. Additionally the methodology must be able to adjust the recommended stockage lists when the answers

change. The STA methodology can measure the impact that stocking of various feasible levels of spares and repair parts at the various locations in the support structure will have on a weapon system's operational performance goals. Therefore, the use of STA will choose the least cost set of stockage lists to locations that will adequately support the operational performance requirements.³⁶

IRO also noted in their report, that they had recognized during the development of the STA methodology, there may be many feasible lists that could ensure that supply shortages do not cause a weapon systems operational performance to fall below a required or desired goal. The STA concept and methodology recommends and advocates the ranking of feasible stockage lists by their item costs, and then chooses the set of lists that provides the highest operational performance at the least cost.

This report continues with an examination of the STA stocking tradeoffs and alternatives. The STA model accepts as input data, information about the units Class IX supply support structure, the weapon systems it uses, and the parts associated with that weapon system. These combined inputs are collectively called parameters of operation or the PO. The STA model generates as outputs, a feasible set of stockage lists, at the least cost. This stockage list will ensure that supply shortages will not prevent a weapon system from attaining its operational performance goals. To

do this the STA model must be able to access the impact that stocking of the same parts at different locations in the supply support structure will have on both costs and the systems operational performance. Additionally, the STA model must also have the ability to access the impact that the stocking of different part locations, will have on both costs and systems operational performance.³⁷

When evaluating the tradeoffs among locations, the report uses a nominal four echelon supply and maintenance support structure depicted at Figure 1, to better illustrate the support for a notional weapon system. The stockage level

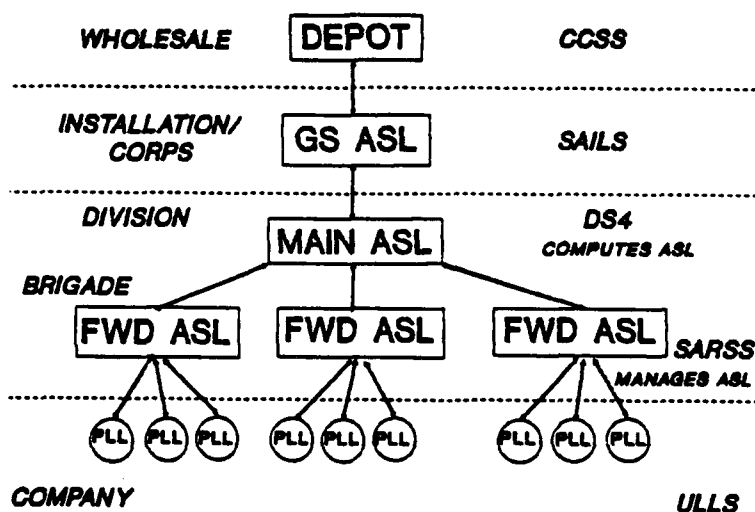


FIGURE 1. SUPPLY SUPPORT STRUCTURE

of an individual repair part at a particular location depends on the following: the demand rate for the part; the stockage quantities of the item at each resupply level, and

the resupply times and OST for that part at all levels of the particular parts resupply path. Therefore, putting a spare part at any location will effect the resupply times for that part at all levels below the parts stockage location.

Additionally, the IRO report states that the Non Mission Capable Supply (NMCS) time is a factor of the stockage levels and the OST for any part requested. Therefore, the stockage of a spare part at any location will potentially impact on the NMCS time for the weapon system at several user locations.³⁸

This AMSAA report further defines for the reader the significance of a units maintenance and resupply concept and its effect on the stockage of repair parts. The STA methodology can effectively evaluate and rank the impact of alternative stockage of additional spares at different locations within the supply support structure.

This impact is best illustrated with the flow of both serviceable and unserviceable parts between a DSU and its supported users as depicted in Figure 2. In the absence of any command directed lateral resupply actions, a spare part located at one of the ORGs will be used to satisfy the NMCS requisition of that ORG only. Whereas, the stockage of a spare part at a DSU will satisfy the NMCS requisition of any requesting ORG, and reduce the requesting ORG resupply time. However, the NMCS impact on the ORG would be less for

the requisitioning unit if the requested spare had been stocked directly at the ORG.

However, this report also states that it is necessary to do more than just determine the distribution of spares to particular locations for stockage. It is equally important to determine the optimal number of spares to stock at each location. STA methodology allocates the budget for the spares based on their impact on both the operational performance and the total budget.³⁹

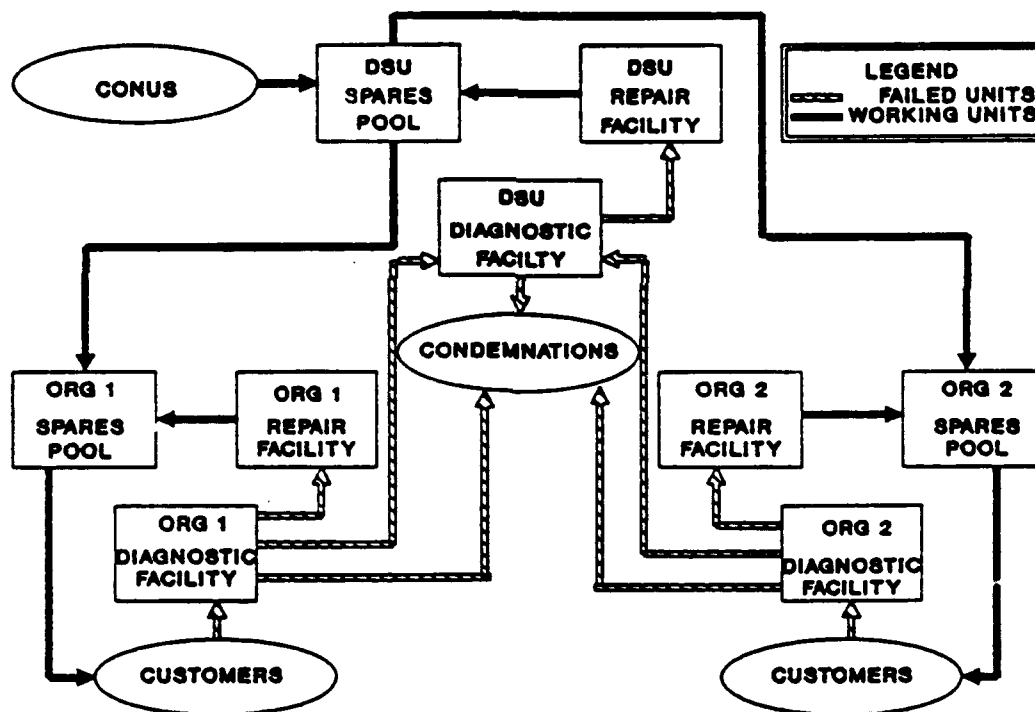


FIGURE 2. FLOW OF UNITS IN A TWO ECHELON SYSTEM.

The STA methodology evaluates the tradeoff of parts by their relative costs. STA will determine for each part and its respective stockage quantity, the marginal increase in operational performance associated with its costs of each

additional increase in stockage. Utilizing this methodology, an optimal mix of spares will be added until the operational performance requirement is adequately met. This concept is best illustrated when considering the stockage of two parts with significantly different costs. With all other factors being equal, one part might cost one dollar, while the other part costs five hundred thousand dollars. Although, these parts could have an identical impact on the weapon systems operational performance, the parts will have a significantly different impact on the budget, and it is not reasonable to assume that it is optimal to stock an equal amount of each of these parts. Another area this report discusses is concerning the impact of Line and Shop Replaceable Units (LRU/SRU) stockage on operational performance. Currently, the US Army's maintenance concept distinguishes between parts used to repair a major end item or weapon system, and those parts used to repair other parts as depicted in Figure 3. Therefore, the tradeoffs between a LRU and SRU are similar to the tradeoffs made on a part between stockage locations. Stocking a particular LRU in a PLL can directly reduce the number of NMCS requisitions submitted by that ORG. Conversely, SRU stockage at the DSU level will eventually reduce the backorder time by allowing the unserviceable LRU to have parts available for repair. Therefore, the STA methodology can evaluate the tradeoff of stocking ORG LRUs

or the stocking of LRUs and SRUs at all echelons where the LRUs and SRUs are repaired, and evaluate its impact on ORG LRU resupply times.⁴⁰

The report further identifies that STA will accept

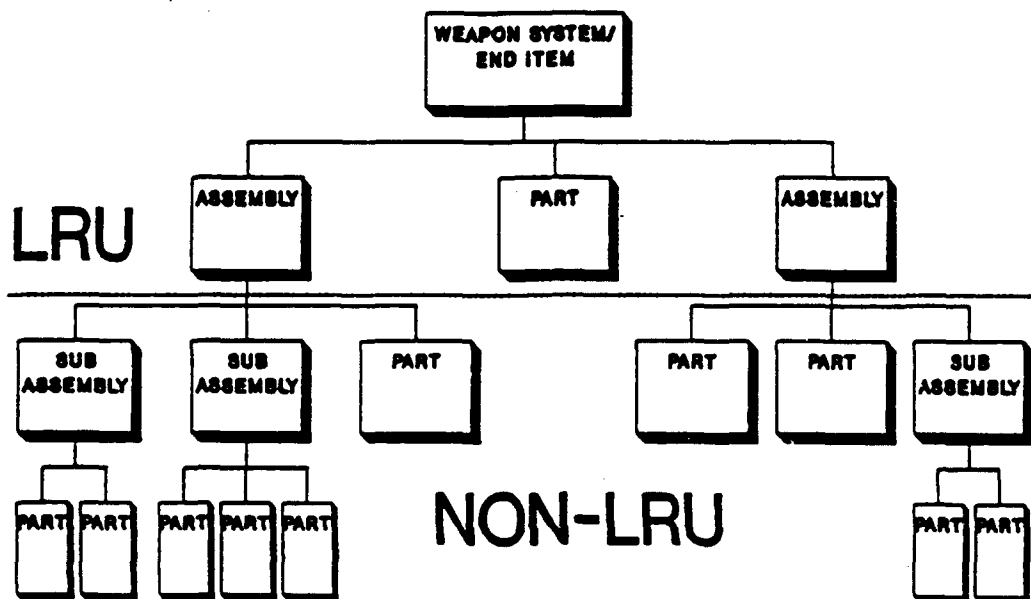


FIGURE 3. INDENTURED PART STRUCTURE.

management constraints as data inputs and will reject any stocking alternatives that are prohibited by these constraints. An unconstrained list of repair parts determined by STA is optimal, for STA will ensure there are no other set of stockage lists that are less expensive and yet ensure that supply shortages do not cause operational performance to fall below the required levels.

A constrained list of repair parts when determined by STA, are considered efficient when there is no other set

of stockage lists that are less expensive and ensure supply shortages do not cause operational performance to fall below the required levels. STA in and of itself does not impose any constraints on the stockage lists other than the internal parameters based on budget and operational performance considerations.

US Air Force Sparing To Availability Model

The concept and subsequent development of a sparing to availability methodology was initiated not only in the US Army but in the other DoD military departments as well. The US Air Force initiated an effort in the early 1960's to evaluate the initial provisioning methodology used to determine the requirements for the replenishment of repair parts needed to support a new aircraft entering its inventory. This effort was undertaken by the RAND Corporation in its Project Air Force program. The RAND Corp was told to utilize the current US Air Force repair parts demand and resupply processes and systems. The RAND Corp developed a new inventory model and methodology, which they called the Multi-Echelon Technique for Recoverable Item Control, or METRIC. The RAND Corp felt this methodology would more accurately determine stockage quantities of high dollar LRUs required to support the new and more complex airplanes that the US Air Force was fielding. Initially developed to support the wartime usage requirements of US Air Force aircraft, the US Air Force utilized a dynamic or

Dyna-METRIC model. Dyna-METRIC is a sparing to availability methodology used to determine the wartime or contingency repair parts inventory requirements (previously used Mod-METRIC as an interim model prior to this most recent modification of METRIC). Surprisingly, the US Air Force only recently evaluated and subsequently started utilizing the Dyna-METRIC model methodology to determine the initial provisioning Class IX stockage requirements for newly fielded systems. Judging from the number of Master's Theses written on this subject, the US Air Force's Dyna-METRIC model currently seems to be an important research topic at the US Air Force's Air University.

For peacetime initial provisioning and replenishment the US Air Force developed the Aircraft Availability Model, a sparing to availability model. This model computes spares at both the wholesale and retail levels simultaneously. The primary reason for this integration of spares is due to the US Air Force's supply procedures and policies.

The US Air Force, similar to the US Army, has organized its supply support system into a wholesale and retail level. However, US Air Force policies require the managers at wholesale level to maintain visibility over the retail level assets so that they can (1) reduce or eliminate procurement when retail activities have excess items and (2) improve operational readiness by redistributing items directly from retail activities that have excesses to those

that have identified shortages.⁴¹ The US Air Force's automated systems normally give wholesale managers visibility over the relatively high cost items that are returned to the wholesale depots for repair, but not over consumable or low cost items that is managed through the Systems and General Support Divisions of the Air Force Stock Fund. Wholesale manager have visibility of these assets is limited to the periodic reports of excess.

A GAO report published in July 1991, identifies that between September 1987 and March 1990, the inventories of US Air Force consumable and low cost items, that were identified as excess to the war reserve and peacetime operating needs, increased from \$442 million to \$927 million, or 110%.⁴² Additionally, the GAO report stated that 90% of the retail level excesses were caused by three reasons: decreasing demands generated by the retail units (i.e., decreasing mission requirements and subsequent decreasing demands), increased customer turn-ins (excess turn-in), and finally repair parts requisitioning problems (i.e., no record of the requisition).⁴³

US Navy Sparing To Availability Model

The US Navy has its own version of a sparing to availability model, however, the US Navy uses two different types of models. The US Navy uses the Availability Centered Inventory Model or ACIM for determining the repair parts requirements for its surface and sub-surface vessels. The

US Navy uses a model called ARROWS to determine the repair parts requirements for its aircraft. However, both models perform the same basic functions: forecasting demands needed to satisfy; deciding which items to stock; determining the depth of stockage; and finally, determining the projected performance of the recommended package. In addition to the use of these sparing to availability models, the US Navy integrates these models with a simulation system called TIGER.⁴⁴

The TIGER simulation model is a discrete event model which predicts operational availability due to random failures and repair of equipment following its use in a multi-phase mission. The TIGER model has been in use by the US Navy for over 20 years, and allows the measurement of equipment operational availability in extremely complex situations. Additionally, the TIGER model ranks the equipment by responsibility for system downtime for further detailed analysis, and also provides to the user the ability to evaluate the items that were marginally selected by the sparing to availability model.

The use of a sparing to availability model to determine repair part stockage lists is not only used by DoD departments, but also by several foreign military organizations. The German Army is currently evaluating the application of a sparing to availability model to determine its repair part stockage requirements. The use of a sparing

to availability model is discussed in a recently published NATO logistics initiatives paper. Additionally, both the Canadian and Swedish Army's are in the process of using a sparing to availability model to determine their respective Class IX repair part inventories.

Section Seven. Commercial Use of Sparing Models

The ability to maintain inventories and determine optimal stockage quantities is a concern not only of the US military, but also a universal concern for any organization that maintains or invests in an inventory. Businesses are continually striving to determine the optimal mix and depth of their inventories, thereby better supporting either their production schedules or direct sales to customers.

Inventory control and management is an important facet and concern to business managers, as well as military leaders. Businesses estimated that 30% of their working capital is utilized in inventory; and that investment in inventory is equivalent to 70% of their total investment in their plants and equipment.⁴⁵ Too much inventory on hand increases the costs associated with maintaining that inventory; too little can create a customer service problem.

One of the major problems associated with business inventory management is stockout; stockout occurs when the required item in the inventory is not available when needed. Stockout can impact both customer relations and satisfaction as well as production and delivery schedules. To

businesses, stockout can mean either the lose of revenue or increased production costs. Stockout is normally caused by the inability to forecast both the amounts of inventory needed and the times in which they will be needed. To ensure the availability of inventory items, businesses evaluate historical demands and forecasts anticipated demands; thus, forecasting provides the link between the business and its environment. The desired results of forecasting is a common set of expectations concerning the level of future business activity and the future demands on inventory.

Businesses have developed many mathematical-statistical methods to forecast the future demands on an inventory. The two most commonly used mathematical-statistical estimation forecasting methods are regression analysis and mathematical smoothing. The technique of forecasting by regression analysis consists of estimating the demands for an item based upon information from one or more factors. Regression analysis is based on the correlation of one event to another. Regression analysis is most reliable with known cause and effect relationships, and in most situations, provides an adequate method for forecasting future demands. However, the accuracy of regression analysis is limited when it is difficult or impossible to isolate the cause and effect relationship

correlation. Although cumbersome, multiple regression analysis is one means to deal with such a situation.⁴⁶

The mathematical method for short-term demand forecasting is mathematical smoothing (this method is best used with a computer). The most commonly used mathematical smoothing technique is exponential smoothing. Exponential smoothing bases the estimate of future demands on the accuracy of previous demands. The new demand forecast is a function of the old demand forecast incremented by some fraction of the differential between the old demand forecast and the actual demands realized.⁴⁷ The primary benefit of exponential smoothing is that it permits the rapid calculation of a new demand forecast without substantial historical records and updating.

There are a variety of statistical methods used for predicting either regular or high demand patterns. The six most commonly used methods for forecasting demands are: issue interval, moving regressions, general exponential smoothing, single exponential smoothing, double exponential smoothing, and triple exponential smoothing. The issue interval statistical method is the least accurate method and the triple exponential smoothing is the most accurate method to forecast demands.⁴⁸

However, even with all of these mathematical formulas, several businesses have developed an inventory model that uses the similar type of methodology as found in

the previously discussed, sparing to availability models. Specifically, the following companies: Hewlett Packard, Pan American Airlines, and General Motors, have developed and use a sparing to availability model to determine their inventory requirements.

Section Eight. Conclusion

There are numerous books, government publications, and professional articles available on inventory investment methodologies, such as Palm's Theorem, general business inventory models, the US Force's Dyna-METRIC methodology model, and the US Army's STA methodology. Additionally, AMSAA has conducted extensive analysis on the comparison of retail Class IX inventories using the same inputs to determine stockage under AR 710-2 policy and STA methodology. AMSAA currently provides monthly STA POP Demonstration performance reports to DCSLOG and other organizations on the two respective STA POP Demonstration sites, the National Training Center, and the 5th Infantry Division (Mech). The monthly performance evaluation reports and analyses published by AMSAA are available, and will be used to conduct the analysis in Chapter 4 of this thesis.

Another great source of information, was a recent study project published by a student at the US Army War College. This report titled Integration of Class IX Retail Supply Initiatives, provides detailed information on the US

Army's other retail Class IX supply initiatives currently either under development and evaluation. This report also examines and analyzes the integration of the US Army's wholesale and retail Class IX repair parts initiatives. One section of this report includes research on the STA POP demonstration.

CHAPTER THREE

RESEARCH DESIGN

This thesis will use a historical comparative research design to analyze and develop the thesis question, IS STA THE WAY? The thesis question is subsequently subdivided into three major elements: first, an examination and subsequent comparison of the effectiveness of an initial provisioning package, when its requirements were determined using both STA methodology and that of AR 700-18; second, an examination and subsequent comparison of the effectiveness of an ASL, when replenishment requirements are determined using both STA methodology and that of AR 710-2; and third, an examination and analysis of the impact when AR 710-2 procedures are changed. Specifically, when AR 710-2 procedures are changed in an attempt to increase the ASL supply performance, while simultaneously trying to reduce ASL inventory investment, i.e., either the number of lines or demands to authorize stockage.

Each phase of the thesis has a particular focus, where the following information will be discussed:

PHASE 1. During this phase, the research will focus on and examine in detail, the results of the BFVS initial provisioning demonstration conducted at Fort Polk,

Louisiana. First an overview will be provided to the reader for background information on the initial provisioning of the BFVS. After providing an overview, I will analyze the results from the initial provisioning demonstration and attempt to identify the relative strengths and weaknesses of using each type of methodology.

PHASE 2. During this phase, the research will focus on and examine in detail both the historical and current data available from the STA replenishment demonstration sites of Fort Polk and the National Training Center. Again, after analyzing the data from each of the two replenishment sites, I will attempt to identify the relative strengths and weaknesses of using each type of methodology, by site.

PHASE 3. This phase will focus on determining the relative impact of changing AR 710-2 demand criteria. Specifically, I will attempt to determine if changing AR 710-2 demand criteria would provide for an improvement in supply performance over current AR 710-2 demand criteria or supply performance utilizing STA methodology.

CHAPTER FOUR

ANALYSIS

While speaking to the students of the Class of 1993 US Army Command and General Staff College, Vice Admiral Smith, Deputy Chief of US Naval Operations stated when do we say it is Good Enough? Is it really worth the extra effort required to get the last 10% from what ever we are doing to achieve the maximum performance?⁴⁹

This chapter will analyze the supply performance of the Sparing To Availability Proof Of Principle (STA POP) Demonstration currently on-going at both the National Training Center (NTC) located at Ft. Irwin, California and the 5th Infantry Division (Mechanized) (5th ID(M)), re-flagged as the 2nd Armored Division and currently located at both Ft Polk, Louisiana and Ft Hood, Texas. Like Admiral Smith's question, this chapter focuses on the question: Is STA Good Enough?

This chapter is organized into three sections. Section one first analyzes and then compares the supply performance of a Class IX initial provisioning package, that provided both unit PLLs and the divisional ASL. This initial provisioning package was developed utilizing both the STA methodology and the procedures found in AR 700-18.

These lists were developed to support the initial provisioning of 219 Bradley Fighting Vehicle Systems (BFVS's) at 5th ID(M) during the period May 1990 through November 1991.

Section two first analyzes and then compares the supply performance of ASL's that were generated to support the STA POP Demonstration sites of both the NTC and 5th ID(M). The data used in this analysis was current as of February 1993. Although the STA POP Demonstration is still on going, the data through February 1993 will be used for the purpose of this thesis.

Section three will analyze the anticipated effects on supply performance when AR 710-2 demand criteria is changed. This section is provided to demonstrate and validate any claims resulting from the thought that if AR 710-2 demand criteria were changed, then AR 710-2 policy would be 'Good Enough'.

Section One. Initial Provisioning Analysis

The objective of this section is to analyze and evaluate the supply performance of a STA initial provisioning Class IX repair parts list for the Bradley Fighting Vehicle System (BFVS) against the supply performance of a Standard Initial Provisioning (SIP) package. Both STA methodology and SIP procedures were used to generate a recommended Class IX repair parts list, needed to support the initial provisioning and fielding of the BFVS

to 5th(M), located at Ft Polk, Louisiana. The period of analysis and evaluation is 18 months, May 1990 through November 1991. Although, 219 BFVS's were fielded at Ft Polk during that time, the evaluation period does not include all BFVS's due to the BFVS fielding schedule.

The supply performance of both the STA and SIP generated lists was evaluated for Class IX repair parts usage, supply accommodation, and systems readiness. However, the supply performance of the unit PLL's was only evaluated against parts usage due to the current inability of the Unit Level Logistics System (ULLS) to adequately determine PLL supply accommodation rates. Unit readiness by company was only reported to its Battalion headquarters, and thus was not available nor evaluated during this demonstration period.

Background

AMSAA, in the fall of 1989, after having conducted other analysis on the anticipated effectiveness of an STA generated initial provisioning package, contacted the Program Manager (PM) of the BFVS to determine if the PM would support a BFVS fielding that utilized an STA generated Class IX repair parts package recommendation. After numerous discussions with the BFVS PM and other agencies and organizations, to include the Commander of the 5th ID(M), AMSAA generated for the BFVS PM an STA generated PLL/ASL package to support the initial fielding of the BFVS at Ft

Polk. AMSAA developed the STA recommended Class IX repair parts list with data provided by the BFVS PM. This data was located in the BFVS's Logistic Support Analysis Record (LSAR). The BFVS LSAR is a data record developed by the BFVS original contractor, Farm Machinery Corporation (FMC). The LSAR identifies the potential or anticipated failure factor for each part used on the BFVS. However, the LSAR also identifies every part that could ever fail; thus using the LSAR data allows for the potential stockage of all parts that have a contractor generated anticipated failure factor. Additionally, the LSAR identifies each parts' failure factor as an integer, therefore, a part with a failure factor of '1' can expect to generate at least two demands per year. The LSAR also identifies the maintenance level at which item repair is authorized, the cost of each individual item, and the essentiality coding of each part, e.g., C, D, and E.⁵⁹

The initial provisioning PLL/ASL package utilizing the STA methodology, was generated and prepared by AMSAA. The SIP generated PLL/ASL list was prepared by the BFVS PM. The approved STA initial provisioning package was available for and issued to the 5th ID(M) units in May 1990. Its delivery coincided with the first BFVS equipped unit completing New Equipment Training (NET). While units transitioned through the BFVS NET, their required Class IX repair parts were provided by the BFVS PM, separate from and not part of this demonstration. Once the BFVS unit

completed NET, the Class IX repair parts support for that unit was transitioned to the responsibility of the Division's STA generated PLL/ASL package. Table 1 shows the schedule for the fielding of the 5th ID(M) BFVS's.

TABLE 1.
FT POLK BFVS FIELDING SCHEDULE

<u>DATE</u>	<u># OF VEHICLES</u>	<u>MO's OF DATA</u>
MAY 90	39	18 MOs
OCT 90	60	13 MOs
DEC 90	60	11 MOs
FEB 91	60	9 MOs

TOTAL:	219 VEHICLES	

Class IX repair parts data was collected by an AMSAA sponsored Field Exercise Data Collection (FEDC) team during the period of May 1990 through November 1991. The FEDC team collected the usage data on the Class IX repair parts requested by both the organizational and direct support maintenance units. Additionally, the FEDC team collected usage data on the Class IX repair parts needed to repair either the Line Replaceable Units (LRUs) or the Shop Replaceable Units (SRUs) by reparable exchange activities.

All analysis and comparisons between the STA and SIP generated PLL/ASL recommendations was conducted in the following manner:

a. Both the STA and SIP generated stockage lists were input to a computer database.

b. All usage data collected by the FEDC team was input to the same database.

c. Actual 5th ID(M) supply performance, management, and control procedures and policies were then 'overlayed' on the database.

d. Actual unit requisitions against the PLL's were then evaluated against both the STA and SIP generated lists.

e. The STA PLL supply performance was actual, whereas the supply performance of the SIP PLL was generated using a computer simulation model, that used the same parameters of the STA package, e.g., order ship time.

During this FEDC data collection period, there were a total of 8,729 requisitions submitted, of which 1,340 were unique National Stock Numbers (NSNs). Additionally, during this data collection period, there were a total of 46,625 individual Class IX repair parts requested by the 5th ID(M) units.⁵¹

Table 2 depicts the relative size in lines and associated cost of the STA and the SIP generated PLL/ASL's to support the BFVS's at Fort Polk.

PLL Class IX Usage

Additionally, Table 2 identifies the anticipated operational availability (A_0) of the BFVS's when supported with the respective PLL/ASL packages.

TABLE 2.

STA PLL/ASL vs SIP PLL/ASL

<u>UNIT</u>	<u>STA LINES</u>	<u>SIP LINES</u>
INFANTRY PLL	349	36
ARMOR PLL	324	27
CAVALRY PLL	383	30
SCOUT PLL	325	26
DIVISION ASL	1177	479
<hr/>		
COST:	\$3.48M	\$3.78M
<hr/>		
PROJECTED A ₀	90%	43%

Table 3 demonstrates the impact that the stockage of Class IX repair parts will or can have on a units supply and readiness performance. Although the unit PLL's were stocked with a large number of Class IX repair parts recommended as by STA (ref Table 2), the units supply performance was directly related having the correct Class IX stockage forward with the unit PLLs.

As depicted in Table 3, the actual usage generated against the STA recommended PLL's, varied from 13 demands to 52 demands. Of these demands, there were a total of 148 unique NSN's requested by the units, that were recommended for PLL stockage by STA.

Conversely, the usage that would have resulted from the recommended SIP PLL's, varied from three demands to 14

TABLE 3.

PLL LINE USAGE BY COMPANY

UNIT	STA	- SIP	COMMON	UNIT	STA	- SIP	COMMON
3/6 INF				4/6 INF			
HHC	30	8	6	HHC	18	7	6
A CO	52	13	10	A CO	35	9	6
B CO	30	7	6	B CO	29	8	5
C CO	36	14	9	C CO	37	14	10
D CO	30	8	7	D CO	41	9	5

5/6 INF				CAV & AR UNITS			
HHC	13	4	4	4/35 AR	17	9	6
A CO	35	13	10	3/70 AR	25	8	7
B CO	30	13	9	1/70 AR	23	8	6
C CO	23	7	5	3/1 CAV	52	14	11
D CO	31	12	9				

demands, of which only 21 were unique NSN's.

When the usage of PLL lines by unit is compared between the STA and SIP packages, the STA generated PLL filled over three times as many demands, than that of the SIP PLL's. The demands satisfied by the units STA generated PLL's, ranged from the high of 4.5 times to a low of 2 times more satisfaction. Although, the STA generated PLL provided an improvement in supply performance over the SIP generated PLL, this performance might be expected due to the higher number of lines stocked in the STA PLL.⁵²

The STA PLL had on average 10 times more lines than the SIP PLL (STA average-345 lines to SIP average-30 lines).

As noted earlier, AMSAA utilized the updated BFVS LSAR database to generate the STA PLL. However, there is a problem associated with the data used to generate the STA recommended PLL's. This is evident because only about five to 15 percent of the STA PLL lines were demanded by the units. Yet, with some refinement, is this 'Good Enough', for this inefficiency was not significant in real terms, and could be reduced with minimal effort.

The STA PLL was only a 37% (\$35,985 vs \$26,128) increase in cost over that of the recommended SIP PLL. Additionally, the average STA PLL weight only increased two percent from the SIP PLL weight (8,275 lbs vs 8,097 lbs). However, the cubic feet of the STA PLL increased by 25 percent over that of the SIP PLL.(196 cubic feet vs 157 cubic feet).⁵³

To determine if the BFVS LSAR database was the primary reason for the low percentage of STA PLL lines demanded, analysis was conducted on the distribution of the failure factors for both the demanded and non demanded PLL Class IX repair parts. The distribution of these failure factors is provided in Figures 4, 5, and 6. These Figures also identify that the majority of parts stocked on the PLL's with a failure factor of less than six were not demanded by the respective units.

FAILURE FACTOR DISTRIBUTION OF INFANTRY STA PLL PARTS

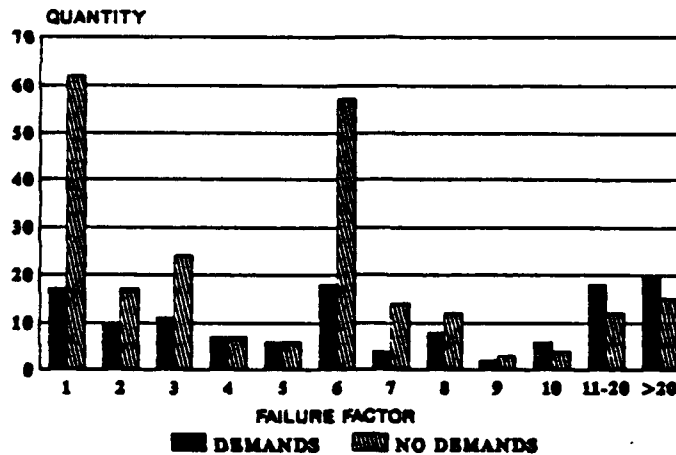


FIGURE 4. FAILURE FACTORS

Based on this data, the probability of significantly reducing the number of lines stocked on the unit PLL's is possible while still providing adequate supply performance to the units.

FAILURE FACTOR DISTRIBUTION OF ARMOR STA PLL PARTS

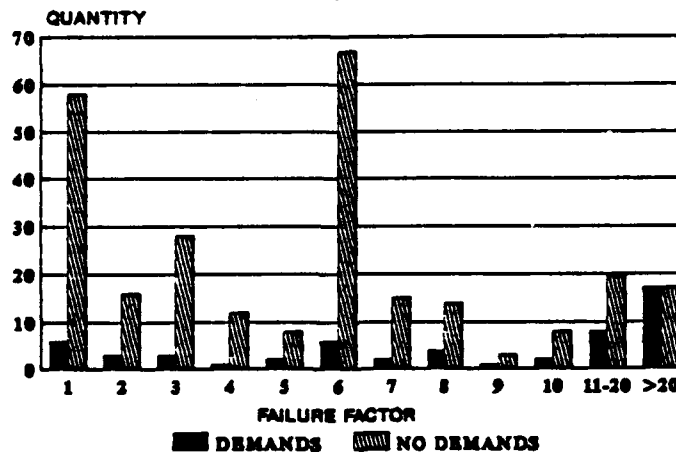


FIGURE 5. FAILURE FACTORS

FAILURE FACTOR DISTRIBUTION OF STA PLL PARTS FOR CAVALRY UNIT

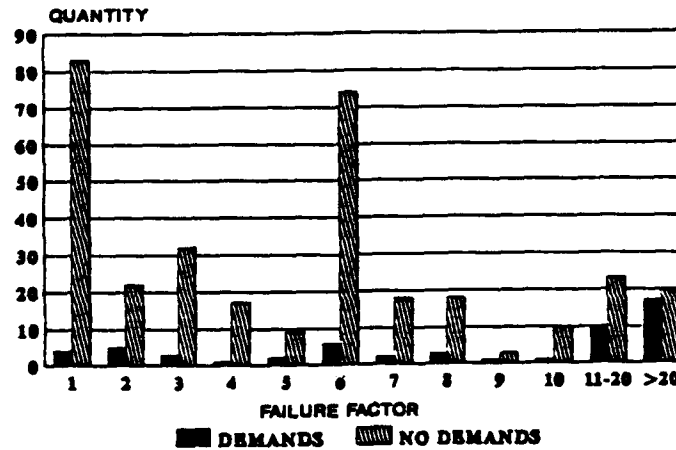


FIGURE 6. FAILURE FACTORS

Figure 7 indicates that 70 percent of all cumulative parts not demanded yet stocked on the STA PLL, had a failure factor of six or less.

CUMULATIVE FAILURE FACTORS FOR STA PLL ITEMS NOT DEMANDED

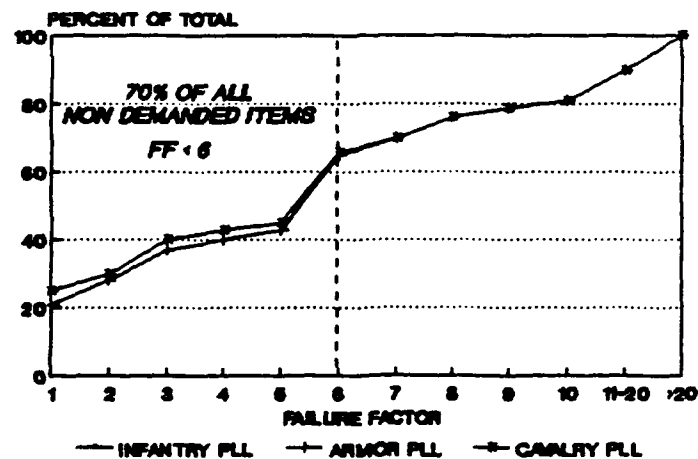


FIGURE 7. CUMULATIVE FAILURE FACTORS

This is possible by either utilizing better data when developing the STA generated package, or through the controlling of input data relative to the parts failure factor.

When parts with a failure factors of one through six are excluded from PLL stockage, the composition of the respective unit PLL's would significantly change.

Table 4 depicts the number of lines that each respective unit PLL would stock if items with selected failure factors were only stocked at the division ASL.

TABLE 4.

PLL LINES WITH FF RESTRICTIONS

<u>MOVE FF <=</u>	<u>INF</u>	<u>AR</u>	<u>CAV</u>
1	272	259	296
1,2	248	241	268
1-3	215	210	233
1-4	203	198	216
1-5	193	188	205
1-6	115	112	123
<u>ORIGINAL</u>	<u>349</u>	<u>324</u>	<u>383</u>

If the items failure factors were used to reduce the number of lines on a unit PLL, any reduction of PLL lines would expect a corresponding reduction in the weight and cube of the PLL.

A unit could expect some degradation in supply

performance due to the logistics delay time that would occur while the requested item (restricted failure factor) was reordered and delivered from the units Class IX supply support activity. However, would supply performance be significantly degraded, or would the supply performance still be 'Good Enough'?

PLL Accommodation Performance

PLL accommodation is a measurement of performance based on the total number of demands found on the PLL divided by the total number of demands. This measurement determines whether or not the demanded item is stocked on the PLL.

The STA PLL accommodation rates were computed using four separate methods, which than compared to the simulated accommodation rates expected with the SIP PLL's. The four methods used to determine the PLL accommodation rates were as follows:

1. PLL demands with an essentiality code of C,D, or E;
2. PLL demands that caused the vehicle to be Non Mission Capable Supply (NMCS) and had an essentiality code of C,D, or E;
3. PLL demands that caused the vehicle to be NMCS, regardless of the essentiality code;
4. All PLL demands.

After computing the overall PLL accommodation, a comparison of the STA PLL demonstrated a high measure of

accommodation than that of the SIP PLL. Figure 8 depicts the increased performance in accommodation that the original STA PLL provided verses the recommended SIP PLL.

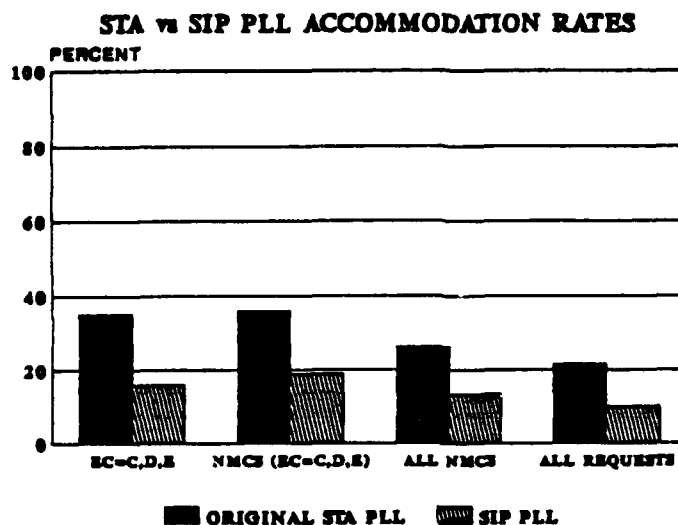


FIGURE 8. ORIGINAL STA vs REVISED STA PLL

Figure 9 illustrates the impact that incorrect essentiality coding had on the effectiveness of the STA PLL.

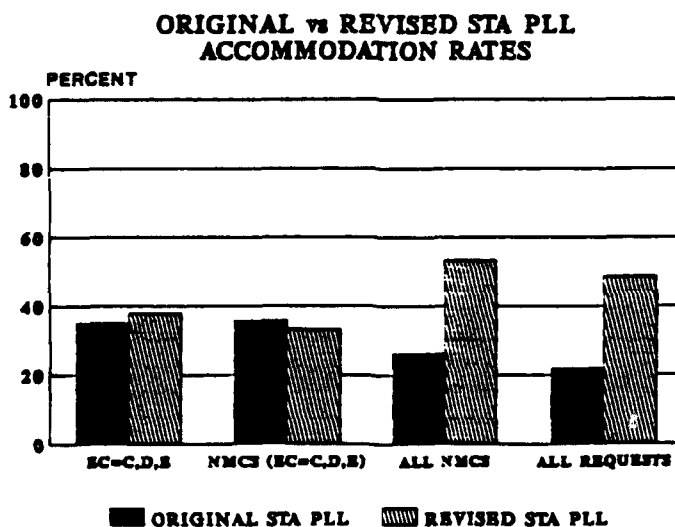


FIGURE 9. ORIGINAL STA vs REVISED STA PLL

Figure 10 illustrates the comparison of the SIP recommended PLL package to that of both the Original STA PLL and that of the Revised STA PLL.

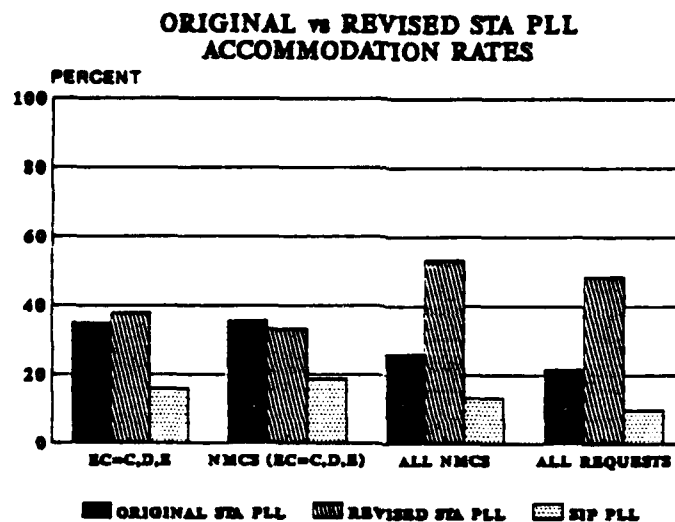


FIGURE 10. ORIGINAL STA vs REVISED STA vs SIP PLL

ASL CLASS IX Usage

After completing the supply performance evaluations on the unit PLL's, the next area of analysis will be the supply performance of the ASL.

Table 5 depicts the number of lines and demands that were generated against both the actual STA ASL and the SIP recommended ASL.

TABLE 5.

STA verses SIP LINES AND DEMANDS

	STA	SIP
# OF LINES	1,177	479
DEMANDS	323	166

As was found when evaluating the usage of PLL parts, the STA ASL provides better supply performance then that of the SIP generated ASL; the STA ASL was able to satisfy two times more demands than the SIP ASL.

Additionally, the failure factor distribution found on the unit PLL's was similarly found on the STA ASL. The majority of the items on the STA ASL had a failure factor of six or less. Figure 11 identifies the failure factor distribution for the STA ASL.

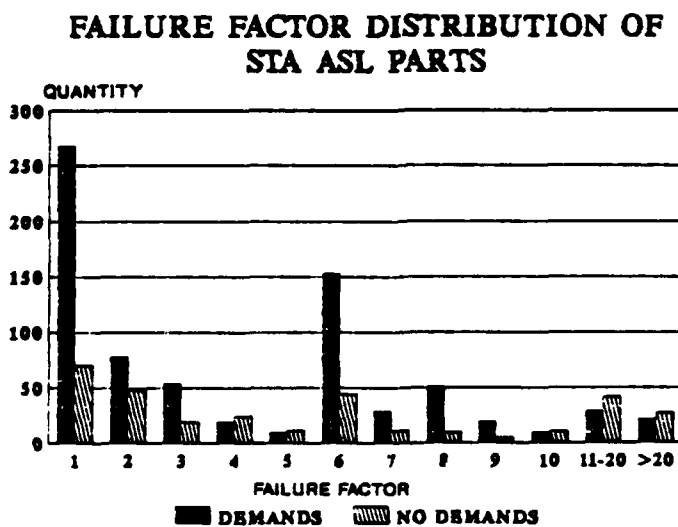


FIGURE 11. ASL FAILURE FACTOR DISTRIBUTION

Figure 12 depicts the cumulative failure factor distribution of all the STA ASL lines that were not demanded.

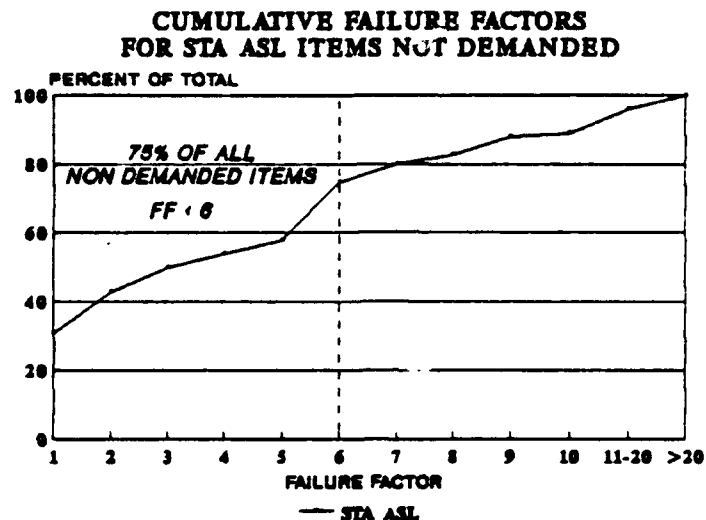


FIGURE 12. ASL CUMULATIVE FAILURE FACTORS

However, the usage rates of parts on both the STA generated PLL's and ASL were not caused entirely by the process in which the STA methodology selected candidate items for stockage.

The usage rates of the STA generated package was primarily caused by Army Master Data File (AMDF) essentiality coding changes. When STA input data was selected in September 1989, the BFVS candidate items for stockage were either: C-Essential item, D-Safety item, or E-Legal or Climatic items. All items selected were currently active NSN's in the US Army supply inventory.

However, after the initiation of the STA initial provisioning demonstration, 118 items had their essentiality coding changed. Additionally, 64 items that still had a valid essentiality code, were changed to either an obsolete or invalid item on the AMDF. Of the 182 total items that were effected by either an essentiality or other AMDF coding problems, 40 of these items were demanded during the STA initial provisioning demonstration.

ASL Accommodation Performance

Although item usage rates were identified as one means to evaluate the STA AT package, the most effective measurement of ASL supply performance is through analysis of the ASL demand satisfaction. ASL demand satisfaction is a measurement of performance based on the total number of completely filled ASL demands, divided by the total number of ASL demands. This measurement determines if the requested item was both stocked on the ASL and stocked in a sufficient quantity to fill all demands.

During this demonstration, ASL supply performance was measured only with ASL accommodation, instead of the ASL demand satisfaction. ASL accommodation is a measurement of performance based on the total number of demands found on the ASL divided by the total number of demands. This measurement determines whether or not the demanded item is stocked on the ASL.

Again, similar to the methods used to determine PLL

accommodation, the same four methods were used to determine STA vs SIP ASL accommodation. After computing the four separate methods, it was found that the STA ASL provided a significant increase in accommodation performance in all four categories. Figure 13 depicts the actual STA ASL vs simulated SIP ASL accommodation performance.

Although all four methods of computing the ASL accommodation demonstrated increased performance, there was the identification of an area that required further analysis. When evaluating the accommodation performance for all ASL NMCS demands, there was an identifiable approximately 20 percentage point decline in accommodation performance from all ASL NMCS demands with an essentiality code of C, D, or E. This finding is inconsistent with the expected accommodation performance expected of an ASL demand causing a vehicle to become NMCS. Therefore, when a demand caused a vehicle to become NMCS, the requested item should also have an essentiality coding of C, D, or E. However, there were 262 items requested that caused a vehicle to be NMCS, yet the item had an essentiality code of either F, identifying a depot level repair item; G, identifying a non-essential item; or as J, identifying a deferred maintenance item.

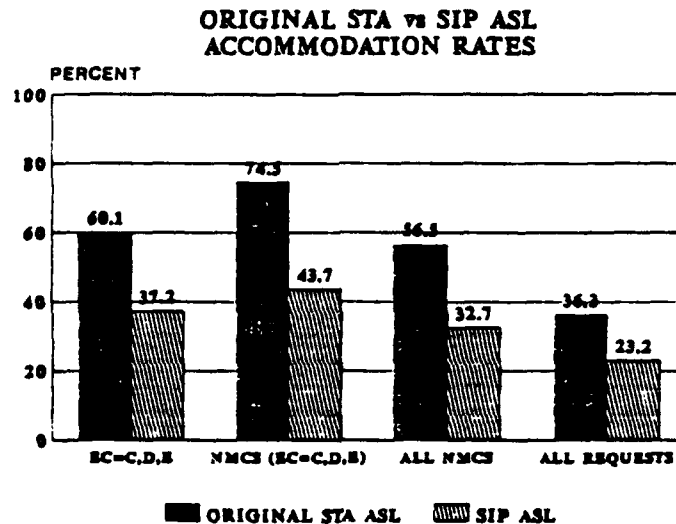


FIGURE 13. ORIGINAL STA vs SIP ASL ACCOMMODATION

When all four methods of determining ASL accommodation performance are considered, the STA ASL performed 23 to 31 percentage points better than the SIP ASL. This increased STA ASL accommodation performance occurred despite the problems found with the essentiality coding of the ASL stockage items.

BFVS Readiness Performance

Another method used to measure and evaluate the effectiveness of the STA PLL/ASL package was through the direct correlation of readiness to the availability of Class IX repair parts. The readiness of both the STA and SIP initial provisioning packages was determined by comparing all demands that caused a BFVS to be considered NMCS.

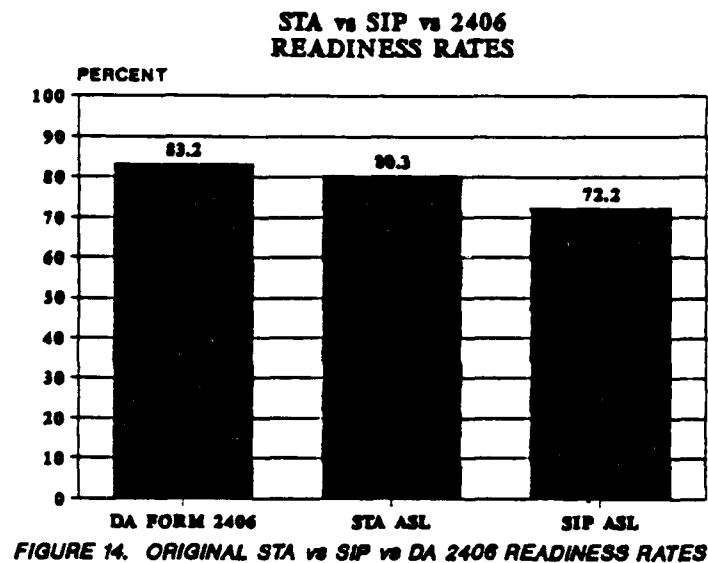
When a demand was generated against a unit PLL, if the item was stocked on the PLL, then the vehicle did not

incur any NMCS time, thus impacting on the BFVS readiness. However, if the demanded item was not on the unit PLL, than the item was requested from the ASL. If the demanded item was stocked on the ASL and on hand for issue, the vehicle would incur one day of NMCS time (equal to the Order Ship Time (OST) from the division to the unit). If the item was not stocked on the ASL, then the vehicle incurred an average of 21 days of NMCS time (equal to the OST from the depot to the division). Additionally, the stockage level of any demanded items found on either the PLL's or ASL was decremented as stockage was issued from either the PLL's or ASL.

Using the previously described procedure, the ASL readiness rates were computed as illustrated with Figure 14. The STA ASL readiness rate was computed at 80.3 percent; the SIP readiness rate was 72.2 percent; and the readiness rate for all BFVS units, as reported by the 5th ID(M) DMMC, was 83.2 percent.

Although the STA readiness rate is better than the SIP readiness rate, it is still less than the 90 percent target of the STA package. Additionally, the 5th ID(M) DMMC reported a higher readiness rate than that of its supporting STA package.

The three percent difference between the 5th ID(M) reported readiness rate and that of the STA package is best explained by the use of either: controlled substitution by

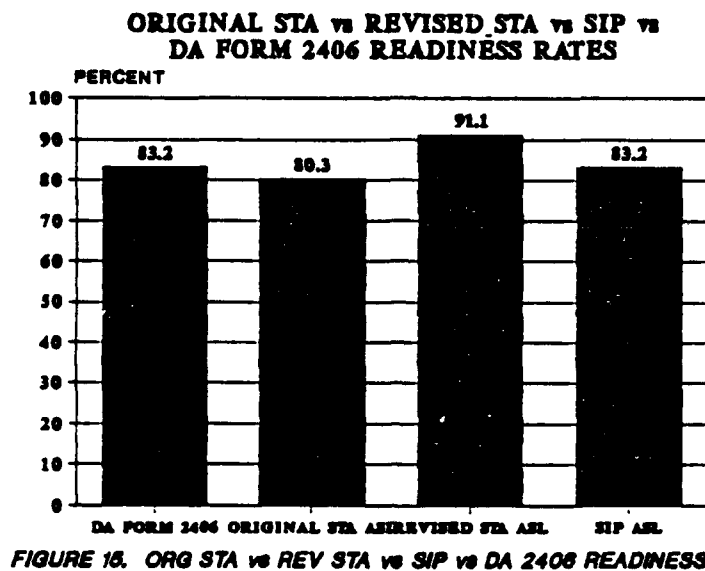


the units; returning a vehicle to Fully Mission Capable (FMC) status during the same day a NMCS demand is generated against a vehicle; and finally, by receiving a demanded item in less time than the expected OST.

If the above listed practices were effectively utilized, the SIP readiness rate could have risen to approximately a 75 percent readiness rate.

The differences between the anticipated STA readiness rate target and that which was actually received is caused by the previously discussed essentiality coding anomalies. There were 262 NSN's that were not coded in the AMDF as essential, yet these NSN's caused 9,762 days of NMCS time during the demonstration period. It is anticipated that STA would have selected many of these items for either PLL or ASL stockage had the essentiality code been correct.

Figure 15 depicts the anticipated readiness rate of the STA package if the 262 items and 9,762 days of NMCS time were removed from the analysis.



Section Two. ASL Replenishment Analysis

With the inaccurate data removed, the STA package would have had a computed readiness rate of 91.1 percent. This readiness rate is closer to the anticipated readiness rate of 90 percent, which was expected from using STA methodology.

While the STA initial provisioning demonstration was ongoing at Fort Polk, AMSAA was advocating for the conduct of an additional STA demonstration. AMSAA was discussing the option with both the US Army Materiel Command (AMC) and the US Army Deputy Chief of Staff for Logistics (DCSLOG).

AMSAA advocated for the initiation of a demonstration site that would enable the evaluation of ASL replenishment, utilizing STA methodology.

Recognizing that any unit participating in this type of STA ASL replenishment demonstration would have to purchase Class IX repair parts previously not stocked; the Strategic Logistics Agency (SLA), a field operating agency of DCSLOG, provided \$5 million dollars in funding to support the transition of a units previously configured ASL to one configured using STA methodology.

Initially, AMSAA discussed this proposal with the 2nd Infantry Division, located in the Republic of Korea. Discussions were also initiated with the National Training Center (NTC) and the 5th ID(M). Discussions were initiated with the NTC due to both its high operating tempo for its equipment and harsh and demanding environment, which typically generate a higher than average number of Class IX repair part demands generated. Discussions with the 5th ID(M) concerning this proposal were logical due to its ongoing participation in the STA initial provisioning demonstration.

Although AMSAA was requesting the formal initiation of a STA replenishment demonstration, AMSAA had previously developed and implemented a similar type of ASL replenishment methodology at FT Rucker in 1988. In 1988, AMSAA was directed by DCSLOG to develop an STA generated ASL

for use by the US Army Aviation Center and School, located at Ft Rucker, Alabama.

In 1988, the Ft Rucker ASL had recently received an inspection by the US Army Audit Agency (AAA). AAA identified a substantial problem with the number of excess Class IX items stocked on the Ft Rucker ASL. After receiving this AAA report, DCSLOG directed AMSAA to develop a STA ASL for FT Rucker. However, AMSAA was also directed to use the current Class IX funding level allocated by FT Rucker. AMSAA therefore utilize the FT Rucker funding level as its optimization input, rather than a desired readiness rate, i.e., 90% readiness rate. AMSAA developed a STA recommended ASL replenishment package for FT Rucker, which was accepted and implemented by the Ft Rucker ASL civilian contractor, in June 1988.

Although, the implementation of an STA generated ASL at Ft Rucker was not an official demonstration, AMSAA, however, collected supply performance data from the Ft Rucker ASL contractor for a period of one year. AMSAA utilized this data to determine both the effectiveness of the STA generated ASL and to additionally identify any problems with the use of the STA methodology or in its implementation. Table 6 depicts the comparison of the previous ASL using AR 710-2 policy and the ASL generated using STA methodology. The comparison and evaluation of supply performance was made during corresponding time

periods, i.e., Jan 91 against Jan 92, etc.

TABLE 6.

FT RUCKER 710-2 vs STA ASL COMPARISON

<u>MEASURE</u>	<u>710-2</u>	<u>STA</u>	<u>CHANGE</u>
FILL RATE	72%	78%	+ 8%
C/EXCHANGE	424	243	-42%
NMCS RATE	12%	8%	-30%
O BAL	14%	11%	-24%
ASL LINES	10,702	15,194	+42%
WORKLOAD	5,746	4,640	-19%

The several observations were made by both Ft Rucker ASL management and AMSAA. The first observation was that although the number of ASL lines was increased by 4,492 new items stocked, representing a 42 percent increase from the previous ASL stockage, the increase was manageable by the number of individuals supporting the ASL. After approximately nine months, the Ft Rucker ASL manager was able to re-assign individuals elsewhere. These individuals had previously been supporting the operation and maintenance of the ASL. The second observation was made, was that the reduction in the receipt of demanded items, resulted in a reduction in the receiving workload. This reduction in workload assisted in the local management decision to re-assign personnel elsewhere.

NTC STA ASL Development/Evaluation

In November 1991, AMSAA developed an STA ASL for the NTC. To develop this ASL, AMSAA utilized the NTC's previous years demand history data. All demand history data was updated with current AMDF information and then separated by weapon system groupings and other special categories. With the current ASL of the NTC supporting over 120 separate end items or systems, the use of weapon system groupings provided a management tool that enabled like items to have stockage determined at the same time, e.g., same series trucks. After separating the items into weapon system groupings, stockage levels were determined to support a 90 percent operational availability (Ao) for each grouping. Several additional data items were entered into the STA model: specifically, the average OST that effected NTC Class IX re-supply times; the Mean Calendar Time Between Failure (MCTBF) times of the major systems supported by the NTC; and the Repair Cycle Time (RCT) for any LRU's that were reparable by the NTC.

Once the STA ASL was generated, a detailed comparison was made by both NTC and AMSAA personnel. The comparison identified and evaluated the differences between the NTC's previous ASL and the recommended STA ASL. Figure 16 identifies the differences between the two ASL's, both in the number of lines and costs.

**NTC ASL COMPARISON
STA ASL vs AF 710-2 ASL**

(NOTE: 16 DAY MOTBF FOR ALL WEAPON GROUPS)

LOCATION	ACTUAL LEVELS (OCT 91)			
	LINEs	CUBE	WEIGHT	DOLLARS
MAIN	6,628	73,288	2,014,676	\$66,468,588
DS/GB ASL	612	68,216	1,381,387	\$61,118,387
ROTA BDE ASL	241	284	16,088	\$118,881
NON-ESS	2,188	16,848	301,668	\$2,662,064
ESSENTIAL	3,884	118,237	3,080,803	\$124,082,807
TOTAL	6,167	131,783	3,382,082	\$126,884,881
UNIQUE				
RO VALUE FOR BOTH STA AND 710-2 ASL's				
LOCATION	STA LEVELS (NOV 91)			
	LINEs	CUBE	WEIGHT	DOLLARS
MAIN	7,907	30,816	811,216	\$6,348,887
DS/GB ASL	368	38,823	888,177	\$48,044,886
ROTA BDE ASL	1,412	1,277	34,883	\$202,986
TOTAL	8,288	68,926	1,884,486	\$61,884,886
UNIQUE				

FIGURE 16. NTC ASL COMPARISON

In January 1992, changes were made to the NTC ASL requisitioning objective (RO) in its DS4 system, to implement the STA ASL. All STA ASL lines were coded to provide for ease in recognition, which additionally enabled AMSAA to identify those items that they had recommended for deletion from the ASL, however, due to a local management decision, would remain on the ASL.

The changes in the NTC ASL RO resulted in the generation of 6,468 requisitions, costing approximately \$2 million dollars. Although, items recommended for stockage yet previously not stocked began to immediately arrive from the NICP's, during the period January through April 1992, the NTC ASL warehouse personnel receipted and stored the either newly stocked or increased stockage items.

The STA ASL POP Demonstration and evaluation did not

commence until April 1992, when approximately 85 percent of all of the STA ASL lines were available for issue.

Understanding that the NTC commander would not authorize the release of items either identified as excess to the recommended STA RO or those items that were NSL; AMSAA understood that the most accurate evaluation of the NTC's ASL supply performance would have to include a method to separate those items from the ASL that were not recommended for stockage.

To better understand and evaluate the impact of the STA configured ASL, three types of ASL configurations were identified and compared:

PRE STA RO (PRE STA) ASL. This ASL was comprised of those items previously stocked on the NTC ASL, to include essential items, provisioning items, and finally all non-essential and non stockage line (NSL) items. However, this ASL only represents a 'snap shot' of those items previously stocked, for the data would not receive additions or deletions, as directed by the required AR 710-2 quarterly ASL review.

PURE STA RO (PURE STA) ASL. This ASL was comprised of stockage as determined by the STA model, and only stocked items coded essential in the AMDF.

On The Ground (OTG) ASL. This ASL was comprised of all Class IX stockage items currently found in the NTC warehouse, to include the STA ASL, items identified as

excess to the STA RO, any non-essential items, and all NSL lines, both essential and non-essential items (data sources dated Feb 93).

Table 7 depicts the comparison between the three ASL configurations.

TABLE 7.			
NTC ASL CONFIGURATION			
	PRE	PURE	OTG
COST	\$126.7M	\$51.5M	\$76.5M
LINES	6,157	8,263	11,724
WEIGHT (LBS)	3.4M	1.6M	3.0M
CUBE (CU FT)	131K	69K	131K
BREAKOUT OF ASL LINES			
ESSENTIAL	2,606	8,263	8,737
PROVISIONING	1,388	0	905
NON ESSENTIAL	2,163	0	2,082

Although there was a 25 percent increase in lines (6,157 to 8,263) from the PRE STA ASL to the PURE STA ASL configuration, there was a significant 60 percent reduction in the costs between the two ASL's.

The primary reason for the significant cost reduction between the PRE STA ASL and the PURE STA ASL is

due to the large number of expensive essential LRU's that were previously stocked with the PRE STA ASL. The OTG ASL has an additional 429 lines that are coded essential, yet not recommended for stockage by STA. These 429 lines cost approximately \$20.6 million dollars, and thus have increased the costs of the OTG ASL accordingly.

Conversely, there was a 29 percent increase in lines (8,263 vs 11,624) from the PURE STA ASL to the OTG ASL. There was, however, only a corresponding 33 percent reduction in costs between the two ASL's.

The NTC STA ASL POP Demonstration is evaluated in the areas of supply performance and equipment readiness rates. Specifically within the area of supply performance the following areas are evaluated: ASL Demand Accommodation; ASL Demand Satisfaction (DA Standard); ASL Fill Rate; Zero Balance with Due Out Rate (DA Standard); and, High Priority Requisition Rates. The evaluation of equipment readiness rates specifically included: Non Mission Capable Supply Rates; Non Mission Capable Maintenance (NMCM) Rates; and Fully Mission Capable (FMC) Rates.

The demand accommodation was computed and compared for the three previously identified ASL's. Demand data was provided during the monthly DS4 supply management output cycles, and was used to determine the OTG ASL demand accommodation. Through simulation, the demand accommodation was determined for both the PRE STA and PURE STA ASL's. A

was determined for both the PRE STA and PURE STA ASL's. A baseline average is provided for comparison, this average of was computed from the previous two years monthly demand accommodation rates. Additionally, the PURE STA ASL demand accommodation was evaluated against only those requisitions that are coded essential, instead of evaluating PURE STA ASL demand accommodation against all requisitions submitted.

Figure 17 illustrates the differences in demand accommodation rates between the three types of configured ASL's.

The STA ASL POP Demonstration average has consistently achieved a higher level of supply performance than the previously configured ASL using AR 710-2 procedures.

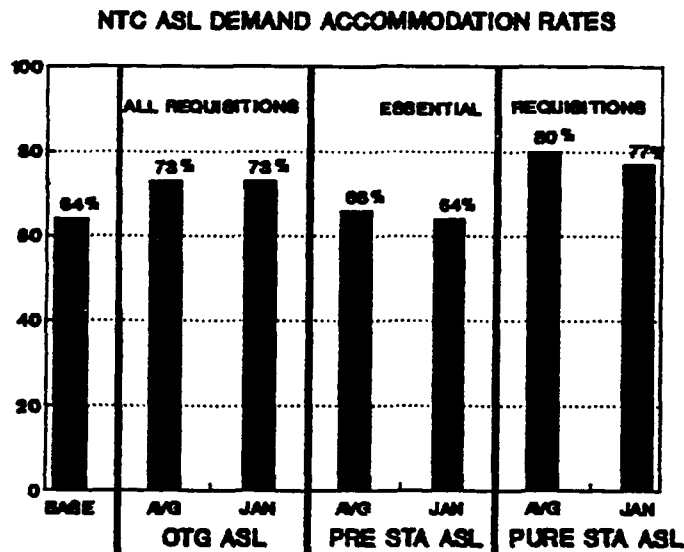


FIGURE 17. NTC ASL DEMAND ACCOMMODATION RATES

Using the data available from the NTC DS4 system, demand accommodation increased by 15.6 percentage points between the demand accommodation of the PRE STA ASL and the PURE STA ASL. During the same period, demand accommodation increased by 9.3 percentage points between the demand accommodation of the PRE STA ASL and the OTG ASL for the same period. Conversely, demand accommodation decreased by 6.4 percentage points between the demand accommodation of the OTG ASL and the PURE STA ASL.

The OTG ASL has demonstrated a noticeable increase in demand accommodation, while significantly reducing inventory costs. Both the OTG ASL and the PURE STA ASL provide for a substantial increase in demand accommodation, more than that of the previous two years accommodation average or that of the NTC's previous baseline demand accommodation.

The same methodology was used to determine the demand satisfaction of the three ASL configurations. Figure 18 illustrates the demand satisfaction performance from each type of ASL configuration.

Demand satisfaction increased by 24.1 percentage points between the demand satisfaction of the PRE STA and PURE STA ASL's. Additionally, demand satisfaction increased by 4.6 percentage points between the demand satisfaction of the PRE STA and OTG ASL's. There was a decrease by 19.5 percentage points between the demand satisfaction of the OTG

NTC ASL DEMAND SATISFACTION RATES

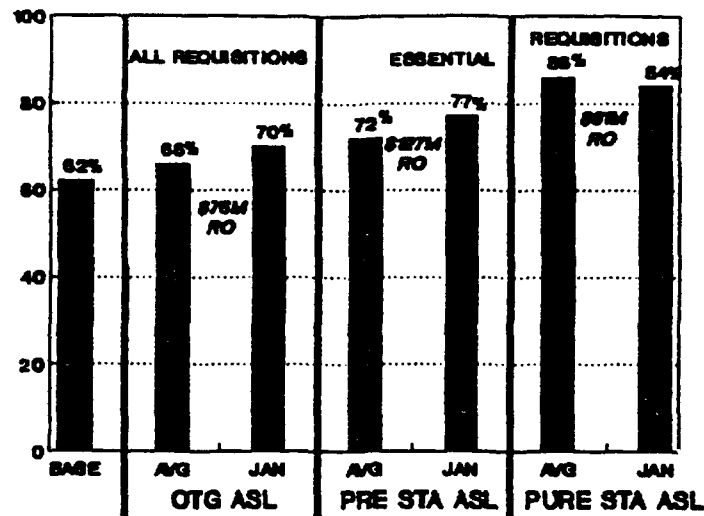


FIGURE 18. NTC ASL DEMAND SATISFACTION RATES

The PURE STA and OTG ASL's again demonstrate an improvement in demand satisfaction while simultaneously providing for a significant reduction in ASL costs. Both the OTG and the PURE STA ASL's provided a more substantial increase in demand satisfaction, more than that of the previous two years satisfaction average or baseline demand satisfaction data (PRE STA ASL) rates.

The same procedure was used to determine the fill rate of the three ASL configurations as illustrated with Figure 19.

The fill rate increased by 23.8 percentage points between the fill rate of the PRE STA ASL and the PURE STA ASL.

NTC ASL REQUISITION FILL RATES

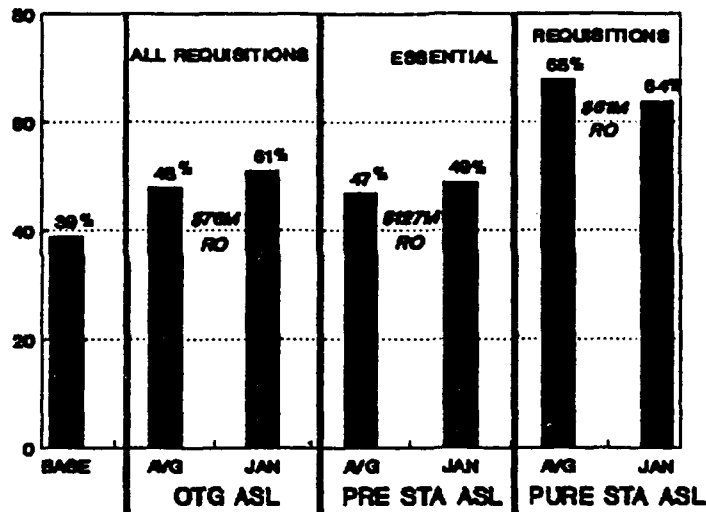


FIGURE 19. NTC ASL REQUISITION FILL RATES

Additionally, the fill rate increased by 9.1 percentage points between the fill rate of the PRE STA and the OTG ASL's. There is a decrease of 28.8 percentage points between the fill rate of the OTG ASL and the PURE STA ASL.

Again, both the OTG ASL and the PURE STA ASL provided for a substantial increase in fill rates, more than that of the previous two years fill rate average or baseline data fill rates.

The next supply performance area evaluated was zero balance percentages with a valid due out. The same procedures were used to determine the zero balance rate for the three ASL configurations. Figure 20 illustrates the zero balance rates for each type of ASL configuration.

NTC ASL ZERO BALANCE RATES

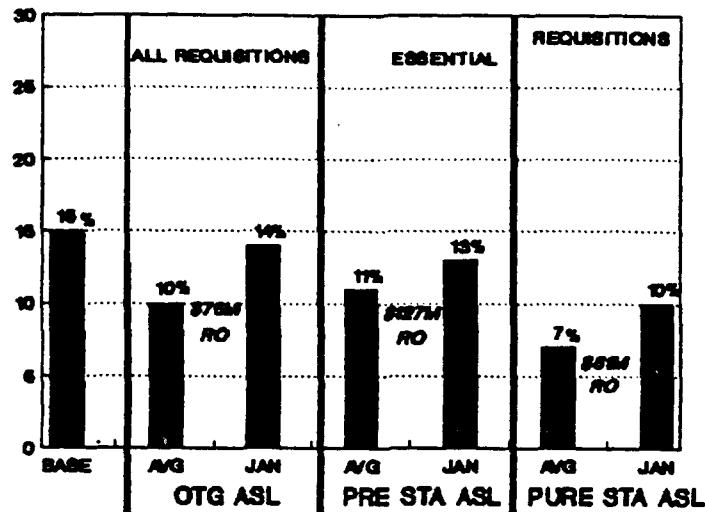


FIGURE 20. NTC ASL ZERO BALANCE RATES

There is a 8.8 percentage point decrease between the zero balance rate of the PURE STA ASL and that of the PRE STA ASL. Additionally, there is a 5.6 percentage point decrease between the zero balance rate of the OTG ASL and the PRE STA ASL. There is a 3.2 percentage point decrease between the zero balance rate of the OTG ASL and that of the PURE STA ASL.

The OTG ASL again provides for a noticeable decrease in zero balance rate while simultaneously providing for a significant reduction in ASL costs. Both the OTG ASL and the PURE STA ASL provided a substantial decrease in zero balance rates, than that of the previous two years zero balance average or baseline zero balance rates.

The next supply performance area evaluated was high priority fill rate. The same procedures are used to

determine the high priority rate for the three types of ASL configurations. Figure 21 illustrates the high priority fill rate for each type of ASL configuration.

The high priority fill rate increased by 19.6 percentage points between the high priority fill rate of the PRE STA and the PURE STA ASL's. Additionally, the high priority fill rates increased by 6.7 percentage points between the high priority fill rate of the PRE STA and the OTG ASL's. The high priority fill rate increased by 12.9 percentage points between the high priority fill rate of the OTG and the PURE STA ASL.

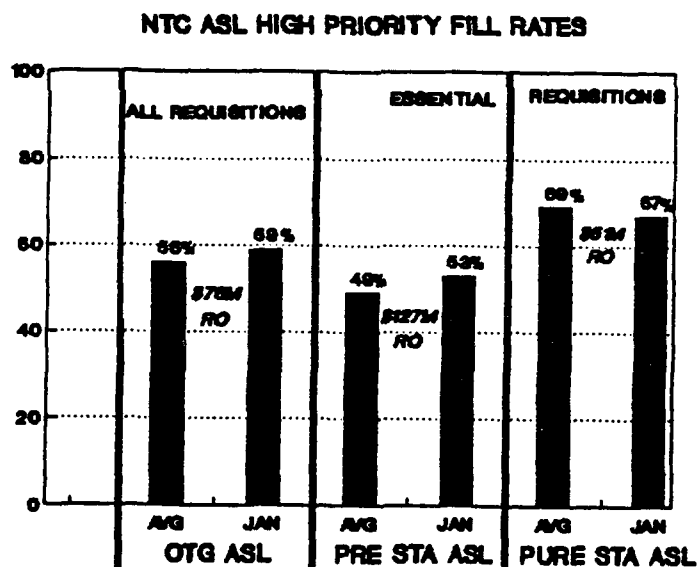


FIGURE 21 NTC ASL HIGH PRIORITY FILL RATES

The OTG and PURE STA ASL's again provided a noticeable increase in the high priority fill rate while doing so at a significant reduction in ASL costs. Both the

OTG ASL and the PURE STA ASL provided for a substantial increase in the high priority fill rates; higher than that of the previous two years high priority fill rate average or the baseline rate.

NTC Demand Distribution

During the period April through June 1992, units at the NTC submitted requisitions that comprised 39,411 demands. Of the 39,411 demands, 60 percent were coded on the AMDF as essential. Of the essential demands, 85 percent were stocked on the STA ASL, three percent were NSL items (OTG ASL), and the remaining 12 percent of the essential demands were not on the STA ASL. Of the non-essential demands, 20 percent were stocked on the OTG ASL.

During this same time period, the number of essential demands for an item was compared to its cost. It was found that only 19 percent of the demanded items cost greater than \$500 per item. The highest number of demanded items had a corresponding cost of between one and ten dollars per item.

NTC Readiness Performance

Another method to measure and evaluate the effectiveness of the STA ASL replenishment demonstration was through the direct correlation and comparison of readiness to the availability of Class IX repair parts.

The readiness rates were computed utilizing the

NMCS, NMCM, and FMC rates reported by the using units on their monthly DA Form 2406 reports. AMSAA organized the DA Form 2406 data into two separate reports, the first identified the NMCS, NMCM, and FMC rates for each type of system, i.e., M1A1 Abrams Tanks, M2 BFVS's, etc; and the second report identified and grouped the NMCS, NMCM, and FMC rates for similar systems, i.e., combat tracked vehicles, tactical trucks, etc.

The readiness of the STA ASL was compared with the SIP readiness rate of June through December 1991. Recognizing this comparison is not the optimum, this was the best possible evaluation system because of the following reasons. First, unit rotations at the NTC were disrupted during both Desert Shield and Desert Storm, June 1991 being the first rotation after Desert Storm; and second, differences in the rotational unit's supply and maintenance policies effect both the number and types of demands generated against the NTC's STA ASL.

The NTC's ASL readiness rates were computed and compared. The STA ASL NMCS rate is three percentage points lower (6%) than the previous years NMCS rate of nine percent. The STA ASL NMCM rate decreased by 13 percentage points from the previous years average of 25 percent. More importantly, the FMC rate of the STA ASL increased by 16 percentage points (82% FMC rate) than that of the previous years FMC average rate of 66 percent.

Additionally, the readiness rates were determined during each month of the demonstration and then compared to the month corresponding to the previous years readiness rates, i.e., January 1992 readiness rates compared with the baseline readiness rates.

NTC MATERIEL READINESS RATES

TIME PERIOD	NMCS	NMCM	EMC	NMCS	NMCM	EMC
JAN 1993	7%	16%	77%	9%	26%	66%
STA AVERAGE	6%	12%	82%	BASELINE (JAN - DEC 91)		
EQUIPMENT	NMCS	NMCM	EMC	NMCS	NMCM	EMC
COMBAT	23%	10%	67%	16%	19%	68%
COMMO	8%	9%	83%	10%	9%	81%
GENERATORS	8%	2%	90%	7%	11%	82%
TACTICAL	7%	13%	80%	7%	28%	66%
WEAPONS	0%	14%	86%	0%	0%	100%

FIGURE 22. NTC MATERIEL READINESS RATES BY GROUPING

Figure 22 identifies the NMCS, NMCM, and FMC rates for selected systems maintained by the NTC ASL. Two of the 10 systems have significantly increased the NMCS time, while one increased slightly.

NTC MATERIEL READINESS RATES

TIME PERIOD	NMCS	NMCM	EMC	NMCS	NMCM	EMC
JAN 1993	7%	18%	77%	9%	26%	66%
STA AVERAGE	8%	12%	82%	BASELINE (JUN - DEC 91)		
EQUIPMENT	NMCS	NMCM	EMC	NMCS	NMCM	EMC
M1A1	7%	32%	61%	6%	12%	82%
M2	3%	30%	67%	16%	38%	47%
M3	12%	44%	44%	24%	31%	46%
M106	4%	23%	73%	8%	23%	69%
M109AS	18%	31%	51%	18%	8%	74%
M113AS	3%	25%	72%	9%	19%	72%
M548	3%	10%	87%	12%	12%	76%
M577	3%	15%	82%	2%	38%	60%
M88A1	27%	13%	60%	24%	23%	63%

FIGURE 23. NTC MATERIEL READINESS RATES BY SYSTEM

Figure 23 identifies the NMCS, NMCM, and FMC readiness rates of the NTC systems by groupings. Again, as illustrated in Figure 22, the Combat Vehicles grouping demonstrated a significant increase in its NMCS rate.

After conducting further analysis to determine the possible reasons why there is such a significant increase in the NMCS rate associated with selected systems, it was found that the selected systems were newly fielded systems to the NTC, i.e., M1A1 tanks replacing the previously supported M1 and IPM1 tanks.

As was found with the STA Initial Provisioning Demonstration, if the data used to determine the initial provisioning package is incorrect (either essentiality codes or failure factors) then STA methodology is not able to determine nor recommend the optimal Class IX parts to

achieve the desired readiness rates for the system.

Additionally, if the units demand history file is either incomplete or incorrect, then again, STA methodology is not able to adequately determine or recommend the optimum parts for stockage on the ASL.

5th ID(M) STA ASL Development/Evaluation

Background

During the same time period that AMSAA was requesting the participation of the NTC be a STA ASL replenishment POP Demonstration site, AMSAA asked the 5th ID(M) command group to allow the STA Initial Provisioning demonstration to be converted from supporting only the 5th ID(M) BFVS's to a complete STA ASL.

The 5th ID(M) authorized the development and implementation of a STA replenishment ASL. The 5th ID(M), however, restricted the ASL from being integrated with new STA lines. The 5th ID(M) was concerned that the increased STA lines would over burden their ability to effectively and efficiently manage the ASL, thus adversely impact on the division's readiness. Therefore, the 5th ID(M) requested that AMSAA provide both a separate area to store the items not previously stocked on the division's ASL, and civilian contractor personnel to manage these new stockage items.

AMSAA contracted with Red River Army Depot supply operations personnel to manage and issue the separate STA

stocks. These stocks were stored in military vans (semi-trailers) provided by Depot Systems Command.

In March 1992, AMSAA developed a STA ASL for the 5th ID(M). To develop this ASL, AMSAA utilized the 5th ID(M)'s previous years demand history data. All demand history data was then updated with current AMDF information and then separated by weapon system groupings and other special categories. After separating the items into weapon system groupings, stockage levels were determined to support a 90 percent operational availability (Ao) for each grouping. Several additional data items were used in determining the stockage levels, specifically, the average OST that effected the 5th ID(M) Class IX re-supply times, the Mean Calendar Time Between Failure (MCTBF) times of the major systems supported by the 5th ID(M), and the Repair Cycle Time (RCT) for any LRU's that were reparable by the 5th ID(M).

Once the STA ASL was generated, a detailed comparison was made by both the 5th ID(M) and AMSAA personnel. The comparison identified and evaluated the differences between the 5th ID(M)'s previous ASL and the recommended STA ASL. Figure 24 identifies the differences between the three ASL's, both in the number of lines and costs that changed.

In April 1992, changes were made to the 5th ID(M) ASL requisitioning objective (RO) in its DS4 system, thus implementing the STA ASL.

FIGURE 24.

5TH ID(M) ASL CONFIGURATION

ASL	LINES	COST	WEIGHT	CUBE
PRE STA	8,483	\$59.1M	3.7M LBS	123K
PURE STA	10,335	\$26.3M	1.5M LBS	62K
OTG (MAY 92)	12,003	\$59.5M	3.9M LBS	132K
OTG (FEB 93)	8,909	\$61.1M	4.7M LBS	133K

All STA ASL lines were coded to provide for ease in recognition, which additionally enabled AMSAA to identify those items that they had recommended for deletion from the ASL. These items, due to a local management decision, would remain on the ASL.

The changes in the 5th ID(M) ASL RO resulted in the generation of over 5,000 requisitions, costing approximately \$2 million dollars. Although, items recommended for stockage yet previously not stocked began to immediately arrive from the NICP's, during the period March through April 1992, the Red River and 5th ID(M) ASL warehouse personnel receipted and stored the either newly stocked or increased stockage items.

The STA ASL POP Demonstration and evaluation did not commence until May 1992, when approximately 85 percent of all of the STA ASL lines were available for issue.

Understanding that the 5th ID(M) commander would not authorize the release of items either identified as excess to the recommended STA Ro items or those items NSL; AMSAA understood that the most accurate evaluation of the 5th ID(M)'s ASL supply performance would have to include a method to separate those items from the ASL that were not recommended for stockage.

To better understand and evaluate the impact of the STA configured ASL, the three types of ASL configurations used to evaluate the supply and readiness performance at the NTC, were similarly used to conduct the comparison of the 5th ID(M) ASL's.

Although there was a 49 percent increase in the number of lines (5,309 to 10,335) from the PRE STA ASL to the PURE STA ASL configuration, there was a significant 45 percent reduction in the investment costs between the two ASL's.

Conversely, there was a 11 percent increase in the number of lines (10,335 vs 8,909) from the PURE STA ASL to the OTG ASL, however, there was a corresponding 58 percent reduction in costs between the PURE STA ASL and the OTG ASL.

The primary reason for the significant cost reduction between the OTG ASL and the PURE STA ASL is due to the large number of expensive essential LRU's that the 5th ID(M) has stocked.

When determining the 5th ID(M)'s ASL Demand

Accommodation, the demand accommodation for the three previously identified ASL's was computed and then compared. Demand data is provided during the monthly DS4 supply management output cycles, and is used to determine the OTG ASL demand accommodation. Through computer simulation, the demand accommodation is determined for both the PRE STA and PURE STA ASL's. A baseline average is provided for comparison, which is computed from the average of the previous one years monthly demand accommodation rates. Additionally, the PURE STA ASL demand accommodation is evaluated against only those requisitions that are coded essential.

Figure 25 illustrates the differences in demand accommodation rates between the three types of configured ASL's. The STA ASL POP Demonstration average has been consistently achieved a higher level of supply performance than the previously configured ASL that utilized AR 710-2 procedures.

Using the data available from the 5th ID(M) DS4 system, demand accommodation increased by 12.1 percentage points between the demand accommodation of the PRE STA ASL and the PURE STA ASL. During the same period, demand accommodation decreased by 2.6 percentage points between the demand accommodation of the PRE STA ASL and the OTG ASL during the same period. Conversely, demand accommodation

increased by 14.7 percentage points between the demand accommodation of the OTG ASL and that of the PURE STA ASL.

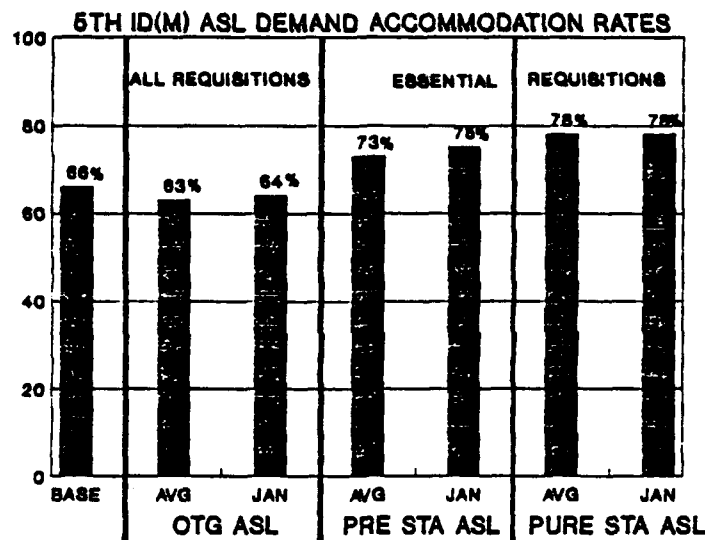


FIGURE 25. 5TH ID(M) ASL DEMAND ACCOMMODATION RATES

The OTG ASL demonstrated a noticeable decrease in demand accommodation, while at a significant increase in inventory costs. Both the PRE STA and the PURE STA ASL's provide for a substantial increase in demand accommodation, more than that of the OTG ASL average.

The same methodology was used to determine the demand satisfaction of the three ASL configurations. Figure 26 illustrates the demand satisfaction performance from each type of ASL configuration.

Demand satisfaction increased by 21.6 percentage points between the demand satisfaction of the PRE STA and PURE STA ASL's.

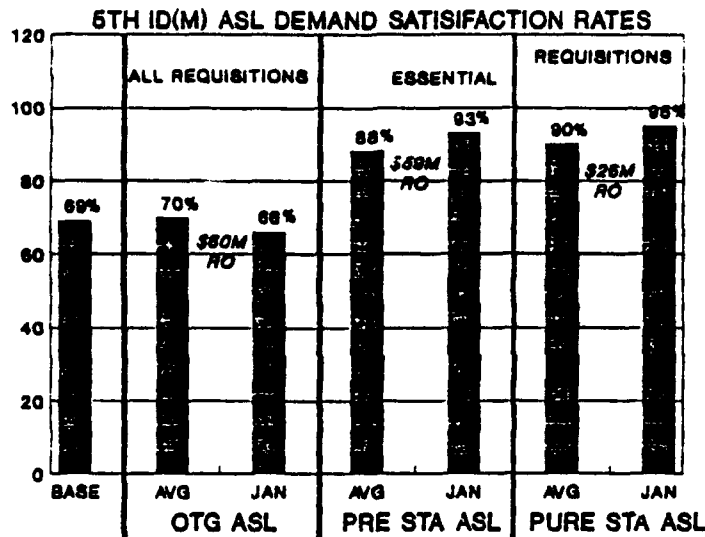


FIGURE 26. 5TH ID(M) ASL DEMAND SATISFACTION RATES

Additionally, demand satisfaction increased by .4 percentage points between the demand satisfaction of the PRE STA and OTG ASL's. There was a decrease of 21.2 percentage points between the demand satisfaction of the OTG ASL and that of the PURE STA ASL.

The PURE STA and PRE STA ASL's again demonstrate an improvement in demand satisfaction while simultaneously providing for a significant reduction in ASL costs. The PURE STA ASL's provided a more substantial increase in demand satisfaction, more than that of the previous two years satisfaction average or baseline demand satisfaction data, PRE STA ASL or OTG ASL rates.

The same procedure was used to determine the fill rate of the three ASL configurations. Figure 27 illustrates the fill rate for each ASL configuration.

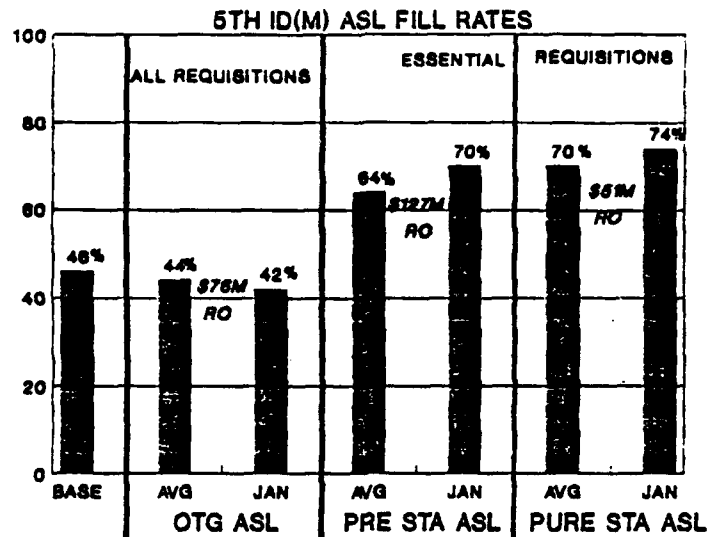


FIGURE 27. 5TH ID(M) ASL REQUISITION FILL RATES

The fill rate increased by 25.2 percentage points between the fill rate of the PRE STA ASL and the PURE STA ASL. Additionally, the fill rate decreased by 1.6 percentage points between the fill rate of the PRE STA and the OTG ASL's. There is a decrease of 26.8 percentage points between the fill rate of the OTG ASL and the PURE STA ASL.

Again, the PURE STA ASL provided for a substantial increase in fill rates, more than that of either the PRE STA ASL or the OTG ASL rates.

The next supply performance area evaluated was zero balance percentages with a valid due out. The same procedures were used to determine the zero balance rate for the three ASL configurations. Figure 28 illustrates the zero balance rates for each type of ASL configuration.

There is a 2.3 percentage point decrease between the zero balance rate of the PURE STA ASL and that of the PRE STA ASL. Additionally, there is a 1.3 percentage point decrease between the zero balance rate of the OTG ASL and the PRE STA ASL. There is a .5 percentage point decrease between the zero balance rate of the OTG ASL and that of the PURE STA ASL.

The PURE STA again provided for a noticeable decrease in zero balance rates while simultaneously providing for a significant reduction in ASL costs.

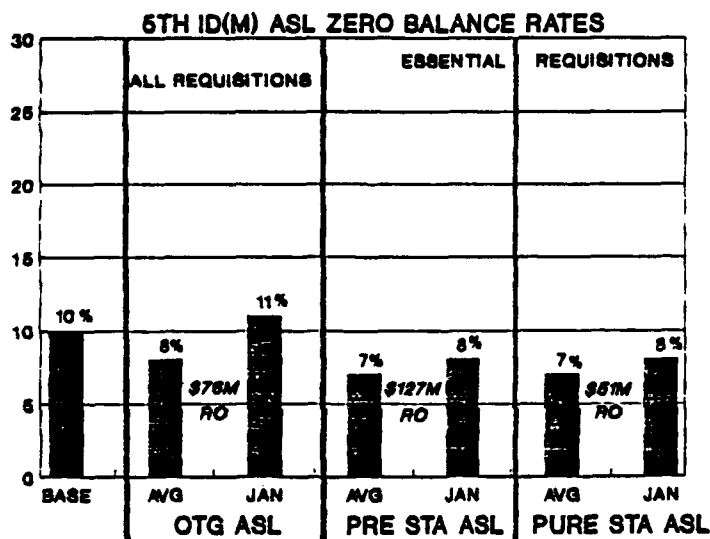


FIGURE 26. 5TH ID(M) ASL ZERO BALANCE RATES

Both the OTG ASL and the PURE STA ASL provided a substantial decrease in zero balance rates, than that of the previous two years zero balance average or baseline zero balance rates.

The next supply performance area evaluated was high priority fill rate. The same procedures are used to determine the high priority rate for the three types of ASL configurations. Figure 29 illustrates the high priority fill rate for each type of ASL configuration.

The high priority fill rate increased by 22.2 percentage points between the high priority fill rate of the PRE STA and the PURE STA ASL's.

Additionally, the high priority fill rates increased by 15.8 percentage points between the high priority fill rate of the PRE STA and the OTG ASL's.

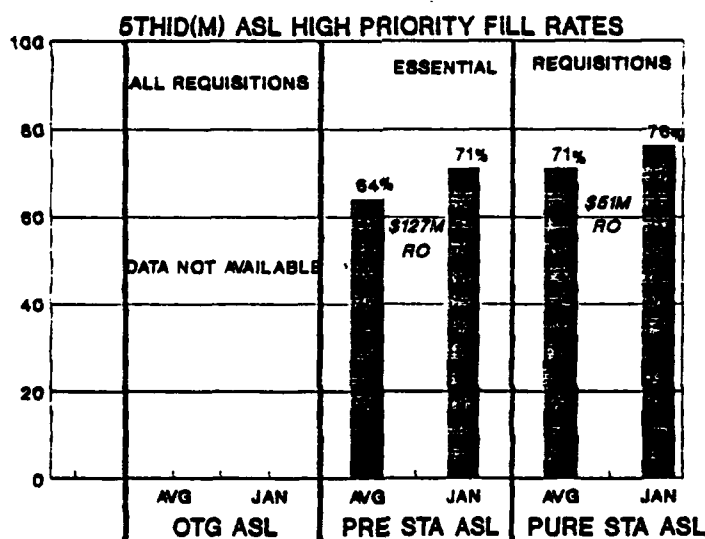


FIGURE 29. 5TH ID(M) ASL HIGH PRIORITY FILL RATES

The high priority fill rate increased by 6.4 percentage points between the high priority fill rate of the OTG and the PURE STA ASL.

The OTG and PURE STA ASL's again provided a noticeable increase in the high priority fill rate while simultaneously doing so at a significant reduction in ASL costs. Both the OTG ASL and the PURE STA ASL provided for a substantial increase in the high priority fill rates; higher than that of the previous two years high priority fill rate average or the baseline rate.

5th ID(M) Demand Distribution

During the period May through June 1992, units of the 5th ID(M) submitted requisitions that was comprised of 45,291 demands. Of the 45,291 demands, 56 percent were coded on the AMDF as essential, while the remaining 44 percent were coded non-essential. Of the essential demands, 81 percent were stocked on the STA ASL, one percent were NSL items (OTG ASL), and the remaining 18 percent of the essential demands were not on the 5th ID(M) ASL. Of the non-essential demands, 18 percent were stocked on the 5th ID(M) ASL, while the remaining 26 percent were not stocked.

During this same time period, the number of essential demands for an item was compared to its cost. It was found that only 8 percent of the demanded items cost greater than \$500 per item. The highest number of demanded items had a corresponding cost of between one and ten dollars per item.

5th ID(M) Readiness Performance

Another method used to measure and evaluate the effectiveness of the STA ASL replenishment demonstration was through the direct correlation and comparison of readiness to the availability of Class IX repair parts.

The readiness rates were computed utilizing the NMCS, NMCM, and FMC rates reported by the using units on their monthly DA Form 2406 reports. AMSAA organized the DA Form 2406 data into two separate reports. The first report identified the NMCS, NMCM, and FMC rates for each type of system, i.e., M1A1 Abrams Tanks, M2 BFVS's, etc; and the second report, identified and grouped the NMCS, NMCM, and FMC rates for similar systems, i.e., combat tracked vehicles, tactical trucks, etc.

The readiness of the STA ASL was compared with the SIP readiness rate during the period of July through December 1991. The 5th ID(M)'s ASL readiness rates were computed and compared. The STA ASL NMCS rate is two percentage points lower (3%) than the previous years NMCS rate of five percent. The STA ASL NMCM rate remained the same, one percent. More importantly, the FMC rate of the STA ASL increased by two percentage points (96% FMC rate) than that of the previous years FMC average rate of 94 percent.

Additionally, the readiness rates were determined during each month of the demonstration and then compared to

the month corresponding to the previous years readiness rates, i.e., January 1992 readiness rates compared with the baseline readiness rates.

Figure 30 identifies the NMCS, NMCM, and FMC readiness rates system grouping. Only the systems in the Electronics group demonstrated a slight increase in NMCS rates.

5TH ID(M) MATERIEL READINESS RATES

TIME PERIOD	NMCS	NMCM	EMC	NMCS	NMCM	EMC
JAN 1993	3%	2%	95%	5%	1%	94%
STA AVERAGE	3%	1%	98%	BASELINE JUL - DEC 90		
EQUIPMENT	NMCS	NMCM	EMC	NMCS	NMCM	EMC
COMBAT	5%	2%	93%	10%	3%	87%
COMMO	2%	1%	97%	3%	1%	98%
GENERATORS	2%	1%	97%	3%	1%	98%
TACTICAL	4%	2%	94%	5%	2%	93%
WEAPONS	4%	0%	98%	7%	3%	90%

FIGURE 30. 5TH ID(M) MATERIEL READINESS RATES BY GROUPS

Figure 31 identifies the NMCS, NMCM, and FMC rates for selected systems supported by the 5th ID(M) ASL. Two of the nine systems illustrated have slightly increased NMCS rates than that of the baseline average.

6TH ID(M) MATERIEL READINESS RATES

TIME PERIOD	NMCS	NMCM	EMC	NMCS	NMCM	EMC
JAN 1993	3%	2%	96%	5%	1%	94%
STA AVERAGE	3%	7%	98%	BASELINE / A - DEC 90		
EQUIPMENT	NMCS	NMCM	EMC	NMCS	NMCM	EMC
M1	5%	3%	92%	8%	1%	91%
M2	5%	1%	94%	12%	1%	87%
M3	3%	3%	94%	20%	3%	77%
M106	5%	0%	98%	12%	2%	88%
M109AS	1%	2%	97%	5%	1%	94%
M113A2	7%	1%	92%	6%	1%	93%
M548	5%	1%	94%	8%	1%	91%
M577	5%	0%	98%	2%	1%	97%
M58A1	15%	7%	78%	21%	4%	76%

FIGURE 31. 6TH ID(M) MATERIEL READINESS RATES BY SYSTEM

After conducting further analysis to determine the possible reasons why there is a slight increase in the NMCS rate associated with the Electronics grouping, none were found other than the possible impact of the local supply and maintenance policies and procedures.

As was found with the STA Initial Provisioning Demonstration, if the data used to determine the STA ASL is incorrect (either essentiality codes or failure factors) then STA methodology is not able to determine nor recommend the optimal Class IX parts to achieve the desired readiness rates for the system.

Additionally, if the units demand history file is either incomplete or incorrect, then again, STA methodology is not able to adequately determine or recommend the optimum parts for stockage on the ASL.

Section Three. Modification of AR 710-2 Demand Criteria

In an effort to evaluate the impact of changing AR 710-2 demand criteria policy and procedures, FORSCOM requested AMSAA develop a methodology that would demonstrate and evaluate the impact of any demand criteria changes.

AMSAA developed a methodology that evaluated the impact of changing AR 710-2 add and retain criteria for items coded essential. AMSAA included initial provisioning items in this methodology also. AMSAA evaluated the supply performance of ASL's with two significantly different add criteria, and eight different retain criteria. Additionally, AMSAA evaluated the anticipated readiness rates of these different add/retain policies, utilizing the STA methodology model.

After developing the demonstration and evaluation methodology, AMSAA conducted an evaluation using the 5th ID(M) PRE STA and PURE STA ASL's. First AMSAA evaluated the distribution of all demands with essentiality codes; C, D, E, and deferred maintenance items - J. Figure 32 illustrates the distribution of all essential coded items demanded by 5th ID(M) units during the last year.

AMSAA determined that 48 percent of all essential demands requisitioned by 5th ID(M) units were for items that had only one or two demands per year. Additionally, 30 percent of all essential demands requested had only three to eight demands for the item a year. Therefore, 78 percent of

all essential demands were for items that had less than eight demands per year. This observation will impact on the ability of the 5th ID(M) ASL to stock items when the add/retain demand criteria are increased.

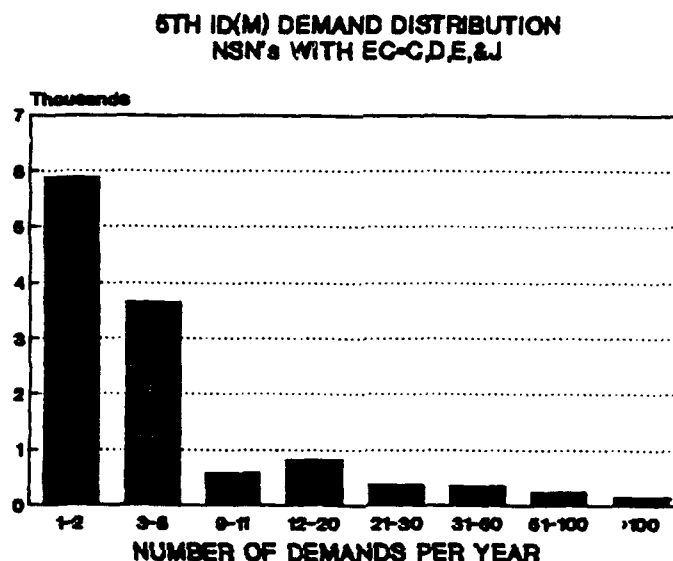


FIGURE 32. 5TH ID(M) DEMAND DISTRIBUTION

Figure 33 illustrates the anticipated number of lines and RO value of 5th ID(M) ASL's when the add criteria for stockage is increased from three demands in a 180 day period to nine and twelve demands, respectively. Additionally, a comparison was made of retain criteria that was increased from one demand in 180 days to the criteria of three, four, five, six, seven, eight, nine, and twelve demands.

Although the number of stocked lines decreased when there were increases in both the add and retain criteria,

the stockage investment does not significantly reduce in value.

5TH ID(M) ASL ADD/RETAIN COMPARISON

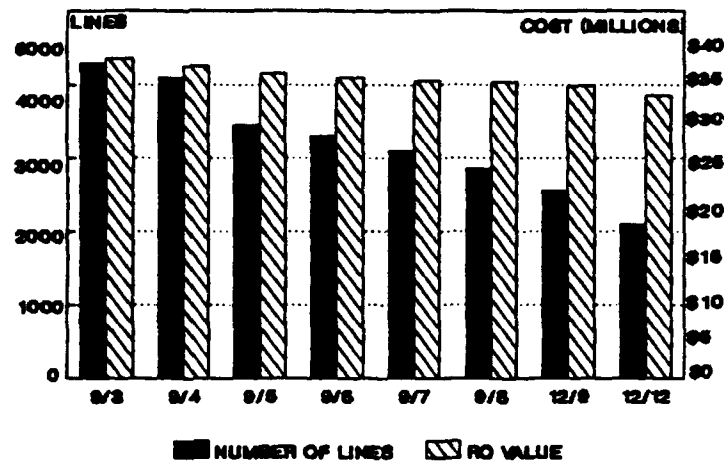


FIGURE 33. 5TH ID(M) ADD/RETAIN CRITERIA COMPARISON

Utilizing the essential demands requisitioned from the previous year, AMSAA determined the supply performance of add and retained changed ASL's. Figure 34 illustrates the anticipated demand accommodation rates generated by only essential demands for the respective ASL's.

5TH ID(M) ADD/RETAIN ACCOMMODATION

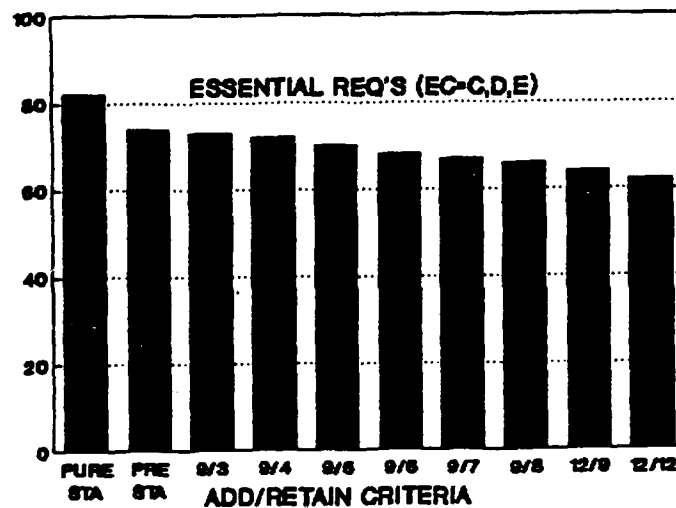


FIGURE 34. 5TH ID(M) ADD/RETAIN ACCOMMODATION

Figure 35 illustrates the anticipated demand accommodation rates for all requisitions on the respective ASL's.

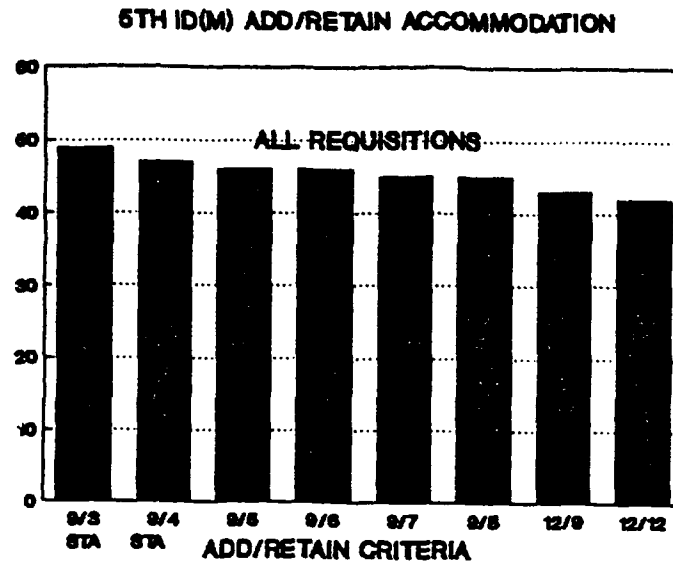


FIGURE 35. 5TH ID(M) ADD/RETAIN ACCOMMODATION

Figure 36 illustrates the anticipated demand satisfaction rates for only essential demands generated against the respective ASL's.

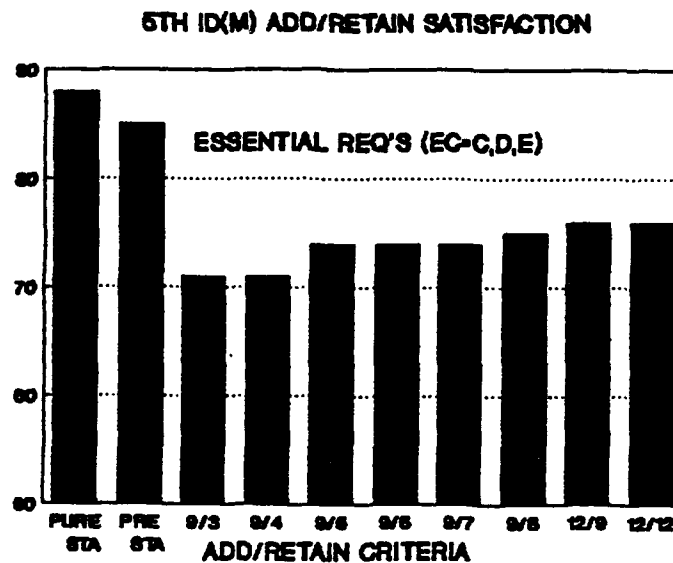


FIGURE 36. 5TH ID(M) ADD/RETAIN SATISFACTION

Figure 37 illustrates the anticipated fill rate for only essential demands generated against the respective ASL's.

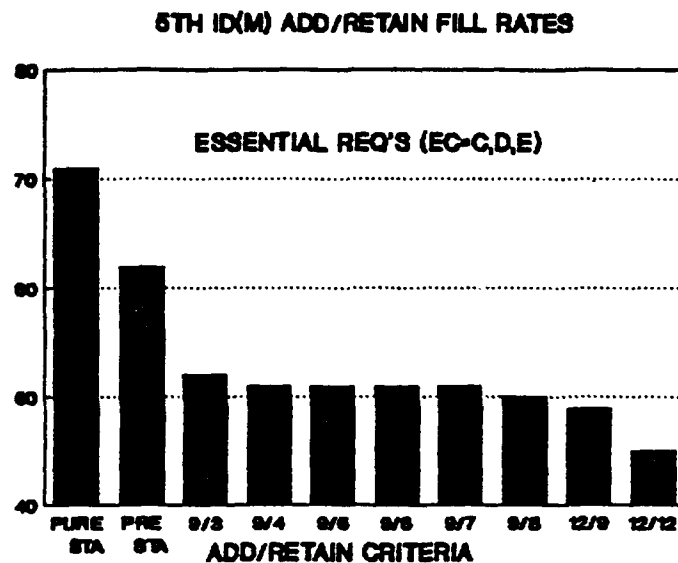


FIGURE 37. 5TH ID(M) ADD/RETAIN FILL RATE

Figure 38 illustrates the anticipated zero balance with a valid due out rate for the essential demands generated against the respective ASL's.

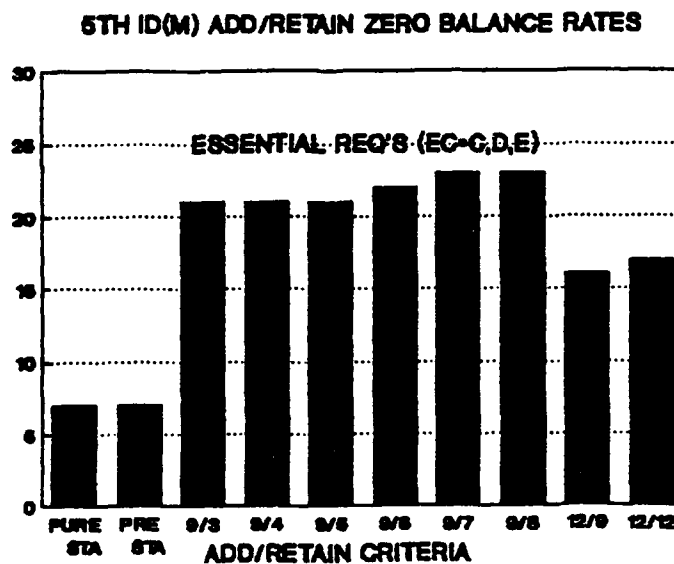


FIGURE 38. 5TH ID(M) ADD/RETAIN ZERO BALANCE RATE

AMSAA then determined the anticipated readiness rates for various weapons systems and groupings, utilizing the STA methodology model. This evaluation was for criteria that enabled the DS4 system to authorize and add stockage after nine demands and retain stockage criteria after three demands.

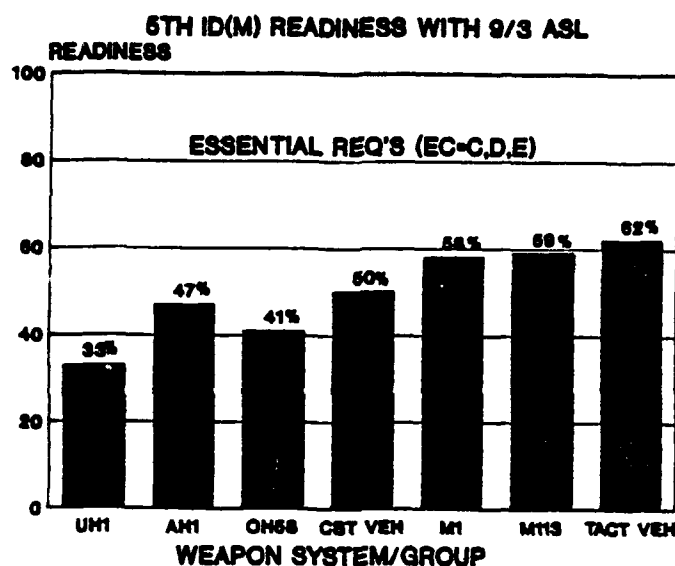


FIGURE 39. 5TH ID(M) READINESS WITH 9/3 ASL

Figure 39 illustrates the impact that this add/retain criteria would have on the materiel readiness rates for selected items.

Conclusion

After having examined the data available from both the STA initial provisioning and replenishment site, I have determined that STA is Good Enough. The limitations of the STA methodology, however, must be acknowledged prior to and

during its implementation and use. These issues are discussed in detail in Chapter Five, the conclusions of this thesis.

CHAPTER FIVE

CONCLUSIONS

This chapter will examine, and discuss conclusions developed from the analysis conducted on the STA methodology demonstrations discussed in Chapter Four. This chapter is organized into the following five sections: STA to Determine Initial Provisioning; STA to Determine ASL Replenishment; Is STA Good Enough?; Recommendations; and Future Studies.

Section One of this chapter will examine the impact and effectiveness of utilizing STA methodology to determine the Initial Provisioning requirements of a newly fielded system.

Section Two of this chapter will examine the impact and effectiveness of utilizing STA methodology to determine replenishment of an ASL.

Section Three will discuss the effectiveness of utilizing the US Army's Sparing To Availability methodology. Additionally, this section will discuss the current limitations associated with the use of the STA methodology to determine either initial provisioning or replenishment requirements.

Section Four will examine and discuss

recommendations that can be developed from the examination of the thesis question; Is STA The Way?.

Section Five will identify any future studies that could be pursued to further develop the thesis question.

Section One. STA to Determine Initial Provisioning

As identified during the analysis of the Ft Polk STA Initial Provisioning Demonstration, the initial provisioning PLL/ASL package generated using STA methodology provided a significantly higher supply performance in the areas of demand accommodation, satisfaction, fills, high priority fills, and zero balance rates. The STA generated package was able to achieve this increased supply performance at a significantly reduced inventory investment cost.

However, the analysis of the Ft Polk STA Initial Provisioning Demonstration also identified problems with both the essentiality coding and failure factors of the STA recommended items. These problems demonstrated the greater impact that using imprecise or incorrect data will have in a precise computer model.

It is my opinion, that acknowledging the problems with both the essentiality coding and failure factors of AMDF items, will better enable the US Army supply support system to respond, address, and correct these problems.

As more systems are fielded that have utilized STA methodology to determine its Class IX stockage requirements during this period of reduced budgets, there is a

significantly better chance of these problems being corrected. In the end, a reduced budget will correct these problems. The US Army can not afford to either under or over stock the Class IX items needed to support newly fielded systems.

Section Two. STA ASL Replenishment

As was identified during the analysis of the data from the two STA Proof Of Principle Demonstration sites, STA methodology is effective in determining the STA recommended Class IX stockage for an ASL. The STA ASL increased significantly supply performance in the areas of demand accommodation, satisfaction, high priority fills, fills, and zero balance rates, while significantly reducing the associated inventory investment costs.

Additionally, STA ASL's demonstrated the ability to decrease a units Non Mission Capable Supply readiness rate, thus potentially increasing a units Fully Mission Capable readiness rate.

However, again the use of incorrect or imprecise input data during the development of the STA ASL's demonstrated an adverse impact on the effectiveness of the STA generated package. This problem has even a greater impact when a unit is fielding new equipment, for the data used to develop the STA ASL is either incomplete or obsolete. Either way, if the unit does not have the correct Class IX items to support all of its equipment, this will

impact on the units materiel readiness rates.

The analysis of the STA ASL replenishment data also demonstrated the adverse impact that local maintenance and supply policies and procedures could have on a units supply and maintenance performance. The 5th ID(M) achieved better supply performance from its PRE STA ASL, than that of the OTG ASL. However, the PURE STA ASL significantly increased supply performance. The use of the PURE STA ASL demonstrates the idea that a commonly made statement about US Army supply: 'more is better', is not necessarily true. The PURE STA ASL demonstrated the ability to achieve an increased supply performance measure at a significantly reduced inventory investment cost.

Section Three. Is STA Good Enough?

What is good enough? It is achieving the same readiness at a reduced inventory investment cost, or is it achieving the desired readiness with less lines, while simultaneously reducing inventory investment costs? To determine if the answer *STA is the way!* is correct, one must first determine what is the actual question.

Some of the under-lying assumptions used in this thesis focus on the requirements of a peacetime army. However, can peacetime efficiencies provide adequate support during wartime? Is it worth the potential lose of applying overwhelming combat power during a crisis to determine the

answer?

I believe the answer can be found in the statements that have been presented in this thesis:

1. The US Army's supply support system currently does not provide adequate retail supply support to units, thus units allow for excess stockage to ensure adequate support;
2. Units requisition a significant number of essential items that do not meet AR 710-2 add/retain criteria;
3. Units will replace the next higher assembly when they either don't have the time, expertise or equipment to properly diagnose or repair a failed assembly, and;
4. The US Army can not continue to afford its high Class IX inventory investment costs.

Using these statements as the basis of the STA argument, then an individual could conclude that STA is the way. However, there are several limitations with the use of a STA model, most significant is that of when incorrect or incomplete data is used during input. The effectiveness of the STA generated output is severely diminished, if this occurs.

However, even with these identified problems associated with the use of either poor or questionable quality input data, STA packages provided for increased supply performance over current systems, either AR 710-2 or

AR 700-18.

STA packages will provide a unit, those items that continually generate low demands, yet under current stockage policies and procedures, are not able to meet the criteria for stockage. Additionally, the STA packages provided this increased supply and readiness performance, at a significantly reduced inventory investment cost.

There are two issues that have not been addressed in this thesis; specifically will the STA package provide the same supply and readiness performance during wartime conditions, and will the number of stocked lines adversely impact on a units ability to perform its mission?

The answer to the first part of this question is in Section Four of this chapter. However, I believe the answer to the second part of the question can best be determined by evaluating the effect that the increased operating efficiencies, automation of supply procedures, and availability of typically low demand items, will have on the units ability to more efficiently utilize its supply and maintenance personnel. There the potential for a unit to become more effective in its management, enabling it to provide an increased level of supply support, during both peace and wartime missions.

Is STA The Way? This thesis supports the conclusion that STA Is The Way.

Section Four. Recommendations

To ensure adequate supply and materiel readiness performance during wartime while utilizing a STA ASL, I would recommend that the adequacy of the STA methodology under wartime conditions be further analyzed.

Additionally, I would recommend that the impact of a US Army wide implementation of STA methodology be evaluated. Although, there is significant inventory investment savings at the retail level, the reduction in costs at the wholesale level in the areas of production contracts, will provide for the greatest cost savings.

Section Five. Future Studies

Based on the thesis question, this thesis develops the potential for additional research and future studies. Specifically, future studies and research could evaluate the effectiveness of the US Air Force's Class IX support during both Desert Shield and Desert Storm. The US Air Force uses a sparing to availability model similar to the US Army's STA model. If an evaluation is conducted on its wartime support, this analysis could identify both the potential and problems of the US Army's use of a similar model during wartime.

Additional research and analysis is also needed in the area of improving the supply performance of an STA ASL that must support the concurrent fielding of new equipment.

ENDNOTES

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⁵Peter N. Fuller, Major, US Army, unpublished personal notes.

⁶US Army, Unit Supply Update, Issue Number 13, Consolidated Glossary, (Washington, D.C.: USGPO, 31 January 1992), pp 1-17.

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⁸US General Accounting Office, Report to the Chairman, Subcommittee on Readiness, Committee on Armed Services, House of Representatives; ARMY INVENTORY Fewer Items Should Be stocked at the Division Level, (Washington, D.C.: USGPO, July 1991), p. 2.

⁹DCSLOG DRAFT REPORT, Army Inventory, The Number and Quantity of Demand-Based Items At the Division Level Can Be Reduced, (Washington, D.C.: USGPO, July 1992), p. 18.

¹⁰Report prepared by Logistics Operations Incorporated, Causes of U.S. Army Class IX Excess At The Retail Level, (March 1988), p. 5.

¹¹GAO Report, Ibid, July 1991, p 10.

¹²Ibid., p. 3.

¹³Ibid., p. 5.

- ¹⁴ Ibid., p. 4.
- ¹⁵ Ibid., p. 5.
- ¹⁶ Ibid., p. 8.
- ¹⁷ Ibid., p. 32.
- ¹⁸ DCSLOG DRAFT REPORT, p. 2-4.
- ¹⁹ US Army Materiel Systems Analysis Activity, Summary of the Use of Sparing-To-Availability in the AMC Community, (Aberdeen Proving Ground, MD: September 1991), p. 2.
- ²⁰ Ibid., p. 2.
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- ²⁴ Ibid.
- ²⁵ Ibid.
- ²⁶ Ibid., p. 10.
- ²⁷ Kotkin, p. 9.
- ²⁸ Ibid., p. 11.
- ²⁹ W.H. Marlow, Modern Trends in Logistics Research, (Cambridge: MIT Press, 1976), p. 224.
- ³⁰ Ibid., p. 224.
- ³¹ Ibid.
- ³² Kotkin, p. 12.
- ³³ Ibid.
- ³⁴ Ibid.
- ³⁵ Ibid., p. 1.
- ³⁶ Ibid.

³⁷ Ibid., p. 2.

³⁸ Ibid., p. 4.

³⁹ Ibid., p. 4.

⁴⁰ Ibid., p. 6.

⁴¹ US General Accounting Office, Report to Congressional Requestors, Air Force Logistics Improved Redistribution of Retail Inventories Needed, (Washington, D.C.: USGPO, July 1991), p. 2.

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⁴³ Ibid., p. 22.

⁴⁴ Peter N. Fuller, Major, US Army, unpublished notes from briefing attended the US Navy Tiger Simulation Model.

⁴⁵ James A. Constantin, Principles of Logistics Management, (New York: Appleton-Century-Crofts, 1966). p. 322.

⁴⁶ Donald J. Bowersox, Logistical Management, (New York: Macmillan Publishing Co, 1974), p. 108.

⁴⁷ Ibid., p. 109.

⁴⁸ Ibid., p. 234.

⁴⁹ Topic discussed during Vice Admiral Smith's presentation to the Class of 1993 Command and General Staff College students, (Ft Leavenworth, KS: 2 March 1993).

⁵⁰ Kevin Shorter, "Bradley Sparing To Availability Initial Provisioning Evaluation at Fort Polk", AMSAA Division Note No. L-92, (Aberdeen Proving Ground MD: June 1992), p. 3.

⁵¹ Ibid., p. 3.

⁵² Ibid., p. 4.

⁵³ Ibid., p. 4.

GLOSSARY

ASL Depth	Quantity of a single item stocked on an ASL.
ASL Range	Size of an ASL in terms of the number of different lines stocked.
Average Customer Wait Time	Average time in days, developed at a supply support activity, required to satisfy customer demands.
Backorder	That portion of requested stock not immediately available for issue and not passed to another source of supply for action.
Excess	The quantity of items over and above the authorized RO.
Operating Level sustain	The quantity of stock intended to normal operations during the interval between receipt of replenishment shipment and submission of subsequent replenishment requisition. Does not include either safety level or OST quantity.
Order Ship Time sustain	The quantity of stock intended to normal operations during the interval between submission of replenishment requisition until stock receipt is posted to the account.
Prescribed Load List	A list of unit maintenance repair parts that are demand supported, nondemand supported, and specified initial stockage repair parts for newly introduced end items.
ReOrder Point	That point, expressed as a quantity of stock, at which time a stock replenishment requisition would be submitted to maintain a stockage objective. This consists of the sum of the safety level, OST, and (if applicable) the repair cycle level.
Repair Cycle Level required	Quantity of reparable type items for stockage, based on average monthly

repair rate and repair cycle time.

Repair Cycle Time	A parameter, expressed as an average, used in calculation of repair cycle level of stock. The cycle begins acceptance of a job by maintenance and ends when the formerly unserviceable asset is returned to stock in a serviceable condition.
Reparable	A secondary item or assembly that can be restored to a serviceable condition.
Requisition	A supply request initiated by a unit in MILSTRAP format.
Requisition item Objective	The RO is the maximum quantity of an authorized to be on hand and on order at any time.
Retail Level	Level of supply below the wholesale level. Retail level stockage generally is oriented toward attaining maximum operational readiness of support units, and therefore is based on demand or item essentiality.
Safety Level	Quantity of stock intended to permit continued support in the event of minor interruption of stockage replenishment or unpredictable fluctuation in demand rate, or both.
Wholesale Level	Level of supply support including national inventory control points, depots, terminals, arsenals, central wholesale data banks, plants and factories associated with commodity command activities, and special Army activities retained under direct control of HQ's DA. Wholesale supply support is accomplished by distributing supplies to retail level for stockage or for issue to users.

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